REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*
19/Feb/2002

2. REPORT TYPE
DISSERTATION

3. DATES COVERED *(From - To)*

4. TITLE AND SUBTITLE
BASE CLOSURE IMPACTS AND THE GENERAL EFFECTS OF MILITARY INSTALLATIONS ON LOCAL PRIVATE EMPLOYMENT

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
MAJ POPPERT PATRICK E

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
UNIVERSITY OF TENNESSEE KNOXVILLE

8. PERFORMING ORGANIZATION REPORT NUMBER
CI02-29

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
THE DEPARTMENT OF THE AIR FORCE
AFIT/CIA, BLDG 125
2950 P STREET
WPAFB OH 45433

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Unlimited distribution
In Accordance With AFI 35-205/AFIT Sup 1

13. SUPPLEMENTARY NOTES

14. ABSTRACT

DISTRIBUTION STATEMENT A
Approved for Public Release
Distribution Unlimited

20020305 174

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF: a. REPORT	b. ABSTRACT	c. THIS PAGE	17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON / 19b. TELEPHONE NUMBER *(Include area code)*
				154	

Standard Form 298 (Rev. 8/98)
Prescribed by ANSI Std. Z39.18

PhD Dissertation Abstract

AUTHOR: Patrick Eugene Poppert

TITLE: Base Closure Impacts and the General Effects of Military Installations on Local Private Employment

RANK: Major

SERVICE: US Air Force

DATE: 2001

NUMBER OF PAGES: ~~143~~ 154

DEGREE AWARDED: Doctorate of Philosophy with a major in Economics

INSTITUTION: University of Tennessee, Knoxville

This study explores general effects of military installations on local employment, and the special case of Base Realignment and Closure (BRAC). A partial adjustment construct is used. Both random and fixed effects specifications of the disturbance term are evaluated. The analysis also includes levels and changes forms of the model. Defense personnel changes are decomposed into positive, negative, and BRAC related components, then examined for asymmetrical effects attributable to the public goods and community infrastructure vacuum brought about through installation downsizing. Economic assistance, and facilities reutilization in BRAC communities are also considered, as are the elasticities of defense employment multipliers with respect to industry specialization and military vs. civilian workforce composition. Instrumental variable techniques are employed. A novel panel data set incorporating 21 years of county level data allows comprehensive examination of defense related employment trends across all 50 states. The collection of sub-county defense personnel figures addresses a shortcoming of other county-level impact studies, which reconcile community employment changes against base closure personnel losses, without consideration of personnel dynamics at other military installations within the same county. There is evidence of asymmetrical relationships between military personnel level changes, and local community employment. While this supports the proposition of favorable effects through reutilization of public and community infrastructure, economic assistance and the practice of outsourcing defense support functions are also identified as contributors to this condition. Results also suggest regional industry specialization and workforce composition have little influence on the effect of local defense employment changes.

To the Graduate Council:

I am submitting herewith a dissertation written by Patrick E. Poppert entitled "Base Closure Impacts and the General Effects of Military Installations on Local Private Employment." I have examined the final paper copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Economics.

Henry W. Herzog, Jr.

Henry W. Herzog, Jr., Major Professor

We have read this dissertation
and recommend its acceptance:

Matthew N. Murray

Robert A. Bohm

Thomas P. Boehm

Thomas P. Boehm

Accepted for the Council:

Vice Provost and
Dean of the Graduate Studies

Base Closure Impacts and the General Effects of Military Installations on Local Private Employment

A Dissertation
Presented for the
Doctor of Philosophy
Degree
The University of Tennessee, Knoxville

Patrick Eugene Poppert
December 2001

DEDICATION

This dissertation is dedicated to
my wife, my children

and

to my parents

ACKNOWLEDGMENTS

There are a number of people to whom I am indebted for my accomplishment at the University of Tennessee. First and foremost, are my father, who gave me the push to go this far, and my mother, who gave me the gift of writing. I am also grateful to a former supervisor, and good friend, James Salter, for honing my research and writing skills. Many thanks go to Jackie Crawford, Richard L'Heureux, and Mickey Dansby for their votes of confidence. I am particularly appreciative of my Dissertation Committee, Henry Herzog, Matthew Murray, Robert Bohm, and Thomas Boehm for their encouragement and support. The merit of this work is due in no small part to their guidance and suggestions. Lastly, my greatest debt is to my wife, for patiently enduring the stress and challenges of graduate school and the monotonous hours of my seemingly unintelligible discourse – she will always be my beacon in stormy weather.

ABSTRACT

This empirical study explores the general effects of military installations on local employment, and the special case of closure under the Base Realignment and Closure (BRAC) proceedings of 1988, 1991, 1993, and 1995. Employment impacts are modeled in a partial adjustment construct, and both random and fixed effects specifications of the disturbance term are evaluated. The analysis also includes both levels and changes forms of the model. The latter approach facilitates decomposition of defense personnel changes into its positive, negative, and BRAC related components. These components are examined for asymmetrical effects attributable to the public goods and community infrastructure vacuum that is created when military installations draw down. The specific effects of economic assistance, and facilities conversion and reutilization in BRAC communities are also considered, as are the elasticities of defense employment multipliers with respect to regional industry specialization and military vs. civilian workforce composition. Two-stage least squares instrumental variable techniques are employed to alleviate concerns over the relationship between the lagged dependent variable and the disturbances.

A novel panel data set incorporating 21 years of military and private industry observations for 963 military installations and 3,092 counties allows comprehensive modeling and examination of defense related employment trends across all 50 states. The collection of sub-county defense personnel figures addresses a shortcoming of other county-level impact studies, which reconcile

community employment changes against base closure personnel losses, without consideration of personnel dynamics at other military installations within the same county.

The study finds evidence of an asymmetrical relationship between military personnel level changes, and local community employment. While this supports the proposition of favorable effects through reutilization of public and community infrastructure, facilities, and housing when bases draw down, economic assistance and the practice of outsourcing defense support functions are also identified as contributors to this condition. Results of the study also suggest the degree to which regional industry specialization and workforce composition influence the effect of local defense employment on community employment is minimal. The exception is the reutilization effects of BRAC related personnel losses, which appear to be less favorable in counties with a strong military presence.

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INTRODUCTION

Problem Statement

> "Because the Congress remains concerned about the local economic effects of closing bases, it could request further study of that phenomenon in order to provide an empirical perspective from which to consider additional base closings."
>
> - CBO, *Closing Military Bases: An Interim Assessment*, 1996

Despite an estimated facilities reduction of 20 percent, or 464,000 acres between the 1988, '91, '93 and '95 Base Realignment and Closure (BRAC) rounds, the Department of Defense (DoD) continues to press for additional infrastructure cuts (GAO, 1998). The Quadrennial Defense Review (QDR), Defense Reform Initiative, and National Defense Panel all conclude aggregate military base capacity exceeds requirements of the strategy and force structure laid out under QDR (OSD, 1998). Even the Congressional Budget Office notes a disparity between existing troop levels and support structure capacity. Specifically, they identified an unexplainable per capita facility square footage *increase* of 33% from 1988 to 1997, despite already completed base closure and reutilization actions (CBO, 1996).

In its 1998 report to Congress, the Pentagon requested two more closure rounds, detailing additional installation excess capacity of 23 percent, along with compelling support for cutting this deadweight. In particular, readiness, modernization, and quality of life were identified as areas compromised by spreading budgets over unneeded facilities (OSD, 1998). Two years later, the call for more BRAC rounds has gone unheeded. Concern over the regional economic impact of BRAC is a likely roadblock to congressional authorization of additional closures. Given the DoD's estimate of 236,000 direct jobs and 120,000 indirect jobs permanently lost under the first four rounds, the implied job loss multiplier of 1.51 is probably at the heart of this concern. But any such closure aversion is only as defensible as the impact estimates themselves. Post-closure studies suggest related impact estimates were exaggerated. A lack of empirical analysis of military base employment effects is probably the cause for this exaggeration. Without the benefit of econometrically derived multipliers, impact estimates were based on less precise methods, such as expert opinion and modified economic base and input-output techniques. A subsequent discussion of economic base and input-output frameworks illustrates that when either of these approaches is adapted to the military base setting, the underlying assumptions often result in upward biased estimates.

Research Objectives

Under the four BRAC rounds completed thus far, both local and DoD pro forma projections of economic consequences to the local communities painted

bleak, if not disastrous pictures. In fact, qualitative studies indicate actual results overall were generally quite mild. Understandably, grassroots lobbying efforts may have influenced some of the inflated forecasts. To some degree local authorities and congressional representatives have incentives to make "their" bases appear as the worst choice for closure relative to other bases under consideration. But that aside, for reasons to be discussed, even objectively derived military base impact multipliers are generally biased upward and do not provide for the possibility of asymmetrical private employment effects. In short, current tools and practices artificially boost the cost side of benefit-cost studies related to realignment and closure deliberations. Given recent political resistance to the Secretary of Defense's seemingly well founded requests for additional closure rounds, impartial and defensible empirical models that reflect the regional economic consequences of closure are much needed. This study developed around that need.

The objective of the proposed study is an employment impact analysis of military base labor forces on local stateside communities in general, and more specifically the impact of base closures resulting from the 1988, '91, '93 and '95 closure rounds. Of course the product of this analysis will be empirically derived military base employment multipliers. Within the scope of this research, the propositions outlined below will be examined.

Propositions

The following research propositions relate to the defense personnel and base closure impact variables of interest in this study. Specifically, they address the county level impact of military base employment in general; the potential offsetting effects of facility reutilization; and local industry and population characteristics that influence the degree of military employment impacts. In all cases, the anticipated effect is on local private industry employment.

Proposition (1): Increases in military base labor force levels spur demand driven positive indirect employment effects in the surrounding communities.[1] This baseline relationship hinges on two characteristics of military installations. First, though much of an installation's support is organic, generally it is not completely self-sufficient. Bases typically host a variety of contracted services such as dining hall operations, construction, general facility maintenance, and repairs. Regardless of where contracts are let, administered, or paid, the contractors' onsite staffs are an increase in local employment and a direct result of the bases' operations. Secondly, since military and federal civilian employees often come from outside counties, they represent a boost in local wage earners; and those with income consume, however modest their marginal propensity to do so. Even the thriftiest must still satisfy the bare necessities of

[1] With the exception of discussions related to Input-Output modeling, the terms "indirect employment effects" and "indirect effects" are used loosely throughout this study to mean indirect *and* induced effects combined.

food and shelter locally. This boost in local consumption generally translates to additional, or induced local employment.

Proposition (2): Decreases in base employment generally exert *positive* indirect employment effects. In other words, defense personnel downsizing – whether it be BRAC related or routine – represents "job creation through job destruction" opportunities for local communities. Specifically, while the overall employment impact (i.e., direct plus indirect jobs) may be negative, supply side factors related to freed labor and private infrastructure (e.g., developed residential communities and industrial facilities) result in asymmetrical, or positive net indirect effects. Expanded discussion of these factors and support for this postulation are provided in the *infrastructure* and *defense dynamics* portions of this study (reference discussions beginning on pages 38 and 43, respectively).

Proposition (3): The overall unfavorable employment impact of base closure is mitigated to some degree by the public goods infrastructure vacuum created through efforts to promote private reutilization of these otherwise idle assets. The rationale for this proposition is discussed at length in the *infrastructure* portion of the background (reference discussion beginning on page 38).

Proposition (4): Export driven regions are less sensitive to military base indirect employment effects than those regions with relatively lower ratios of

basic to nonbasic activity. It stands to reason that highly specialized regions export more, producing proportionally less for internal consumption. For these regions, employment growth is determined to a greater extent by outside demand. Therefore, employment effects of exogenous shocks, such as defense workforce expansions or contractions, are less pronounced in specialized regions. As an extreme example, personnel increases at a base located in a largely export driven county, like one of those comprising the Detroit MSA, will probably have only a small incremental impact since outside demand for automobiles is the major determinant of employment for this region.

Proposition (5): The effects of military base employment changes are relatively more pronounced in communities with proportionally smaller non-defense labor forces. This is expected because small economies are typically less developed and therefore not achieving their full potential for scale economies. Therefore, as the ratio of base personnel to the local labor force increases, the underlying effect of base employment changes on local employment is likely to be stronger. Conversely, as this ratio decreases, defense personnel employment effects are less pronounced. This distinction is particularly important in the case of defense downsizing (ordinary or BRAC related), when the local defense-to-labor force ratio is generally decreasing and the value of the corresponding change variable is necessarily negative. Consequently, the favorable employment pressures postulated in Proposition (2) are *less* pronounced under this proposition when the actual signs of the observed

values are taken into account. The GAO's descriptive statistics hint at this eventuality. Specifically, of the small BRAC communities, only 44 percent reported employment rates above the 1997 national average, as compared to 60 percent when all major BRAC sites (small and large) were considered.[2]

[2] Reference GAO (1998).

Chapter II

BASE CLOSURES AND ECONOMIC IMPACTS

The Need for Closure

Recognizing the DoD support structure was excessive given the services' roles and missions, Secretary of Defense Robert McNamara launched efforts in the early 1960's to reduce defense activities for 954 installations, to include closure of 60 major bases (Lall and Marlin, 1992). The process spanned 16 years and it wasn't always easy. As with all defense programs, reductions and closures proceeded only when specific funding was authorized and appropriated by Congress in response to the services' annual budget requests. Of course this process left room for inefficiencies in the form of bill riders, political chit redemptions, and logrolling. For those representatives who weren't successful in protecting their constituents from a requested closure, the process was sometimes politically painful. Not surprisingly, this ad hoc approach was interrupted in 1977 when the services were prohibited from unilaterally making major realignments and adjustments to their supporting structure of military installations. Specifically, at bases of 300 or more civil service employees,

U.S.C. Title 10, Section 2687 mandated Congressional approval for restructuring actions that impacted more than 1,000 *or* half the resident federal workers.

At the height of U.S. involvement in Vietnam, the DoD employed 4.9 million military members and federal civilians. By 1975, when active participation in this conflict ended, the defense workforce numbered 3.2 million (see Figure 1 below). Despite this 35 percent reduction in standing force and subsequent changes in national objectives, U.S.C. Title 10 effectively precluded further reductions to the defense infrastructure.

In 1989 the Berlin Wall toppled. Just two years later, member states regained their independence as the former Soviet Union all but dissolved. After

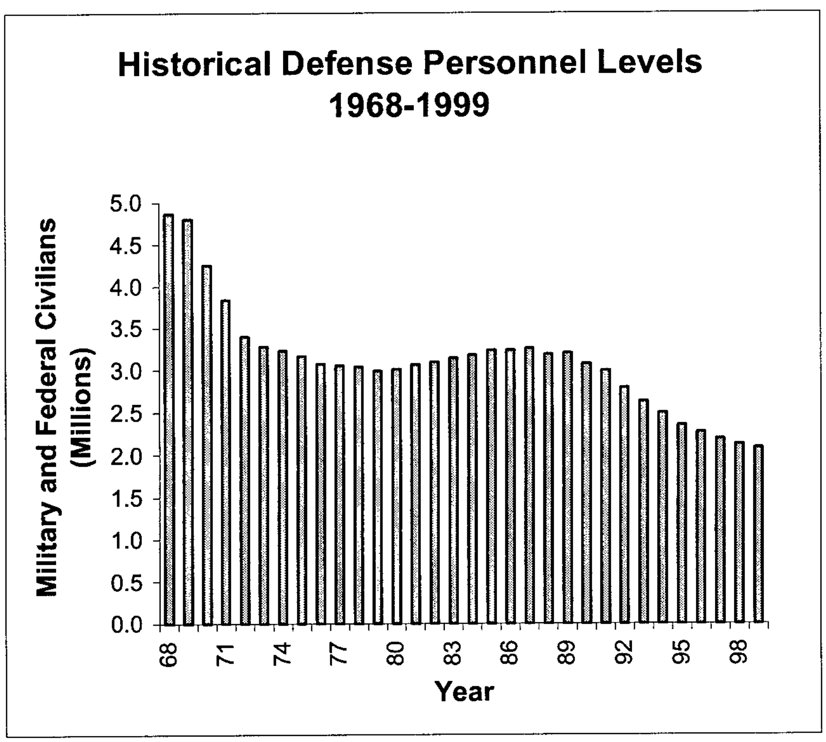

Figure 1 - Defense Personnel Levels

46 years of maintaining the military forces and arsenals necessary to support *Containment,Mu tual Assured Destruction,* and *Détente* foreign policies, the United States watched the Cold War thaw. Having already anticipated the withering of its greatest potential threat, the U.S. began work on a peace dividend in the late 1980s. The plan called for another sizable reduction in DoD personnel levels and military hardware inventories. Ultimately, this phased draw-down released 1.2 million defense employees from 1988 through 1999. Along with these personnel actions, command structures were downsized; carrier groups, divisions, air wings, and strategic forces were slated for reductions in size or complete deactivation; and, weapons systems purchases were curtailed, or "stretched" over longer delivery horizons. With the exception of Operations Desert Shield and Desert Storm, overseas presence was scaled back over this same period. The political leadership was compelled to acknowledge fewer stateside bases were required to sustain post-Cold War operations for a department that was to shrink to 43 percent of its 1968 manpower level. Under the concept of scale economies, some form of military base consolidation and closure was eminent. The tremendous burden of maintaining infrastructure with excessive capacity needed to be lifted, or readiness and much needed weapons modernization and quality of life programs would suffer.

Base Realignment and Closure Process

Under the DoD force restructuring of the late 80's, the details regarding personnel and program priorities were left to the military chiefs and service

secretaries for the most part. However, base closure and restructuring was another matter. As implied by U.S.C. Title 10, concerns over base closure site selection extended beyond departmental walls. Certainly, the representatives of small towns whose largest employer was the DoD had more than a passing interest in the process of identifying stateside garrisons of 3,000 to 20,000 troops for dissolution. Recognizing the inevitable, Congress authorized establishment of the Defense Base Closure and Realignment Commission to inject integrity in the process and preclude logrolling.[3]

Essentially, the BRAC was designed as a body of nonpartisan members whose charter was to: (1) solicit realignment/closure candidates along with supporting facts and figures from the military services; (2) objectively evaluate the services' recommendations, making changes where deemed appropriate; and (3) forward the commission's recommendations to the President. The President was restricted to disapproving the BRAC's proposal in its entirety, or approving and forwarding it to Congress. The Congress was constrained similarly; line item adjustments to the list were not allowed. If the Congress did not push the proposal back to the BRAC Commission for reconsideration within 45 days of receipt, it became law. The services were given six years from passage of the law to execute the approved closure plan (OSD, 1998).[4]

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[3] Since establishment of the Defense Base Closure and Realignment Commission, the acronym BRAC, for "Base Realignment and Closure," has become the accepted reference to both the commission and the process (e.g., "the 1991 BRAC" or "BRAC '91")

[4] For the first BRAC (1988), the commission itself was charged with identifying closure and realignment candidates, and the Secretary of Defense and Congress were the final review and approval authorities.

The approved candidate selection criteria used by the DoD for its submissions to the BRAC Commission are outlined in Figure 2. The first five criteria suggest DoD mission requirements and cost considerations ranked well above economic concerns. In fact, under the last two BRAC rounds, eight of the 61 major facilities approved for reduction or closure were still endorsed despite the fact they were located in "highly vulnerable" communities.[5] In general, the BRAC process seems to have supported DoD's selection criteria and priorities over "not in my backyard" politics. Bielling's 1996 analysis of base closure selection dynamics lends empirical support to this notion.

Direct Effects of Four BRAC Rounds[6]

The first BRAC convened in 1988. Subsequently, Congress authorized three additional BRACs; one each in 1991, 1993, and 1995. Between these four rounds, a total of 261 stateside activities, to include 97 major installations, were identified for reduction or closure (Siehl, 1996).[7] The mean net reduction through September 1998 was 4,109 military and civil service employees per base, for a total of 398,592 personnel across all 97 installations. Losses at individual sites

[5] In 1992, the Defense Conversion Commission designated areas with defense-related employment of 20 percent or more "highly vulnerable." 72 such areas (MSAs and counties) were identified (Siehl, 1996).

[6] Sources for personnel figures are the fiscal year end *Department of Defense Distribution of Personnel by State and by Selected Locations* (M02 Reports), for 1987 through 1998. Accordingly, values presented here are as of September 30, 1998, Due to instances where adjustments were not complete by 1998, these figures do not reflect final personnel levels under BRAC.

[7] For purposes of this study, a major BRAC facility, installation, or base is defined as one employing at least 300 military and defense civilians in 1987 or thereafter. The 97 sites deemed major are listed in Appendix B .

Military Value

1. The current and future mission requirements and the impact on operational readiness of the Department of Defense's total force.

2. The availability and condition of land, facilities and associated airspace at both the existing and potential receiving locations.

3. The ability to accommodate contingency, mobilization, and future total force requirements at both the existing and potential receiving locations.

4. The cost and manpower implications.

Return on Investment

5. The extent and timing of potential costs and savings, including the number of years, beginning with the date of completion of the closure or realignment, for the savings to exceed costs.

Impacts

6. The economic impact on communities.

7. The ability of both the existing and potential receiving communities' infrastructure to support forces, missions and personnel.

8. The environmental impact.

Figure 2 - DoD's BRAC Candidate Selection Criteria

Source: Office of the Secretary of Defense. *The Report of the Department of Defense on Base Realignment and Closure.* Washington DC: OSD, April 1998.

ranged from less than 100 to as many as 19,800, with the median value being 2,937. Seventy of the major BRAC bases experienced losses of 1,000 or more.

In some cases, a given community hosted more than one installation. For example, the 97 major BRAC bases fell within 88 counties (or 59 Metropolitan Statistical Areas (MSAs) for the 70 BRAC counties associated with an MSA). Furthermore, a number of minor facilities affected by BRAC and a few major bases experiencing restructuring outside the BRAC realm shared some of these same communities. These co-located installations may have lost or gained personnel. From the community perspective, the net defense personnel losses through September 30, 1998 averaged 4,529 at the county level, and 6,756 per MSA for the major BRAC localities. The hardest hit communities were Monterey County, California and the Philadelphia PA-NJ Primary MSA (PMSA), with losses of 19,800 and 33,005 respectively.

The fiscal savings under the four BRAC rounds are substantial. As part of the DoD's major force reduction and reshaping measures, base closures have contributed greatly to the overall reduction in defense spending. While White House estimates place the savings of all these initiatives at 36 percent -- or $136 billion across eleven years beginning with 1989 -- BRAC is expected to reduce spending $57 billion over a 20-year window for its part (Siehl, 1996).

Indirect Effects of BRAC

At the time of this study, 9-10 years of post-BRAC data are available for the first round, but only 2-3 years can be collected for BRAC '95. Furthermore,

the gates are still open at as many as 18 of the major BRAC bases slated for realignment or closure. Consequently, little has been accomplished in the way of rigorous, comprehensive examinations of BRAC impact on local communities. However, there are a few qualitative assessments and limited empirical studies that suggest the impact may have been short-lived and not as severe as anticipated for a number of communities.

The General Accounting Office (GAO) examined closure impacts on local communities, choosing real per capita income (PCI) growth rates, and unemployment rates as the status indicators (GAO, 1998). Of 62 communities party to 88 major base closures, 60 percent had lower unemployment rates than the national average at the start of BRAC (1988), while that number improved to 68 percent by 1997. With respect to PCI, 55 percent of 49 major BRAC locales examined surpassed the national growth rate, while 41 percent exhibited negative growth for the period 1988 to 1991.[8] In contrast, 63 percent of these same areas exhibited growth rates equal to or greater than the national rate from 1991 to 1995. Of the 18 communities with below national average rates, only five reflected negative growth. An interesting point made in the study is that the national average PCI growth rate was only 0.2 percent for 1988 to 1991, whereas the same rate for 1991 to 1995 was 1.5 percent. In other words, with respect to PCI, a large number of the BRAC communities seem to have lead the national economy in post-recession recovery.

[8] Thirteen communities impacted by BRAC '95 were excluded in the GAO's PCI analysis since data were not yet available.

To test the idea that metropolitan areas withstand closure impact better than smaller economies, the GAO compared deviations from aggregate U.S. unemployment rates and PCI growth rates of the smaller closure communities with the overall BRAC values. The results are inconclusive. Only 44 percent of the small communities had an unemployment rate below the 1997 national average, as compared to 60 percent when all major BRAC sites are considered. But 71 percent of the rural sites had higher PCI growth than the national rate (1991 to 1995), as compared to 63 percent when small and large BRAC communities are combined.

Finally, the GAO provided a qualitative assessment based on a sample of six BRAC sites visited. The localities were selected for their diversity in population, geography, and general economic conditions. Based on interviews with community officials, the GAO concluded the impact of BRAC was less negative than anticipated for these regions. "Though some communities encountered negative economic impacts during the transition from the announcement of base closure to recovery, local officials said they are optimistic about the long-term outlook for their communities... they now view base closure as an opportunity for their community to craft a new identity for itself and diversify the local economy." Factors submitted by the GAO to explain the better than expected outcome at most BRAC sites are summarized in Figure 3.

In general, the Congressional Research Service (CRS) also concluded base closure impacts were not ruinous (Siehl, 1996). Of the 95 major BRAC areas examined, only 33 had unemployment rates of 5.9 percent or higher for

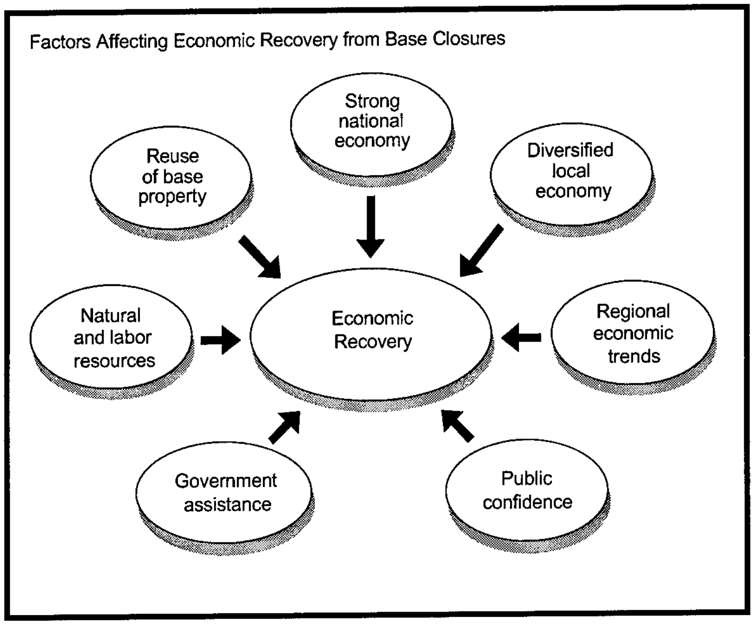

Figure 3 - Economic Recovery Factors Suggested by GAO

Source: General Accounting Office. *Military Bases: Status of Prior Base Realignment and Closure Rounds.* Washington DC: GAO, NSIAD-99-36, 1998.

May 1995. Interestingly, a pattern was evident in these 33 communities. Specifically, two-thirds fell in just three states (14 in California, five in Louisiana, and three in Texas). Though not explicitly stated, the implication is once again that non-BRAC economic factors may have the strongest role in deciding a given community's fate. In either case, the report offers some optimism with regard to closures, stating "... if reuse continues to show an increase in jobs, a reduction in adverse effects from military neighbors (such as noise, overflights, etc.), and redevelopment of military facilities that enhances communities, then congressional opinion may favor additional financial savings through [more] base closures."

As part of its 1998 report to Congress, the DoD assessed the impact of BRAC in terms of unemployment compensation to federal civilians (Office of the Secretary of Defense, 1998). A sample of thirty major closure bases was examined. The DoD found participation was approximately 14 percent of those eligible to draw compensation. However, since some tracking offices served multiple bases – BRAC and non-BRAC – and a number of claimants were victims of the general defense draw down, the true figure was likely something less than 14 percent. In either case, these results imply at least 86 percent of the affected federal civilian workforce either relocated within the government, found non-federal employment, retired, or voluntarily chose not to return to work.

For those former civil servants who drew benefits, the average length of unemployment was 17 weeks. Weekly payments were around 73 percent of the average maximum allowable amounts. Details were not available to explain the deviation from maximum payments, but one possibility is the mandatory offsets for temporary wage earnings of the displaced federal workers as they sought permanent employment.

The DoD estimated total unemployment compensation payments to federal civilians directly impacted by all four BRAC rounds would approach $90 million. This estimate covers a span of 14 years (FY88 through FY01). In contrast, over the period FY94 through FY97, *annual* unemployment claims reimbursements from the DoD to the states averaged $100 million. Ceteris

paribus, BRAC related claims are expected to represent less than 1/14, or 6.4 percent of all DoD unemployment claims.

The RAND Corporation conducted a limited review of BRAC impacts on local communities, and found that in general impacts were neither "catastrophic" nor "as severe as forecasted" (Dardia, 1996). These conclusions were reached through examination of three of California's largest BRAC bases: George Air Force Base (AFB) in San Bernardino County, Castle AFB in Merced County, and Fort Ord in Monterey County. The study focused on a number of descriptive measures for the neighboring communities. Specifically, for the period 1991-1994 (1989-1994 in the case of George AFB), it considered changes in populations, K-12 enrollments, labor force sizes, unemployment rates, taxable retail sales levels, local government revenues, available housing units, vacancy rates, and average home sales prices. The benchmarks for assessing economic toll were various experts' predicted results; the economic status of a paired, or matching non-BRAC installation for each of the three bases; and the experiences of non-neighboring communities in the same counties as the three sites. Of course the researchers provide the disclaimer that the study is too limited for results to be extrapolated across all BRAC sites. Nevertheless, it yields some valuable insight.

With regard to the expert forecasts, in many cases the actual results were appreciably more favorable than predicted. For example, while local K-12 enrollment was expected to decrease 30 and 50 percent at George and Castle, respectively, George actually experienced positive growth, and the drop at Castle

was closer to ten percent. Only city revenue and K-12 enrollment projections for Fort Ord, employment figures for George, and the population forecast for Castle were within five percent of actual outcomes. The latter was the only case where results were *less* favorable than forecasted for the 12 comparisons made.

Under the paired-bases comparison, RAND attempted to match non-BRAC bases having similar missions, personnel levels, and rural characteristics with George, Castle, and Fort Ord. The counterparts were Vandenberg AFB, Beale AFB, and Camp Pendleton, respectively. The matches were by no means precise, but perhaps adequate enough to draw the very general conclusion that the local economies probably would have experienced more favorable economic conditions had the three bases not closed. The authors freely recognize their study does not support conclusions about the degree of difference between actual and hypothetical outcomes, and that it marginally supports statements about the direction of these would-be metrics. But, a fairly reasonable inference of their work is that the non-BRAC component of local economic trends may overshadow BRAC related impacts. For example, all eight metrics for George were approximately the same or significantly *more* favorable than those of Vandenberg, even though George was the base that closed.[9]

RAND's final comparison was between economic conditions in the immediate vicinity of George, Castle, and Fort Ord, and those of their respective counties. In the latter two cases, the authors find general support for the

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[9] Comparative metrics were population, housing units, vacancy rates, unemployment, labor force, city revenue, K-12 enrollment, and retail sales.

expectation that the brunt of BRAC impacts are felt most at the sub-county level. Specifically, for most of the metrics the local values were of the same sign but lagged, or were less favorable than the county level figures. In the case of George AFB, the local community approximated or led the county's performance to a considerable degree. This unexpected outcome suggests that unrelated regional factors may have a role in mitigating the negative impact normally expected from base closure.

Economic Relief

Accommodation of the United States' long-term armed forces posture was the DoD's primary focus during BRAC deliberations. But the closure process and the parties involved were not oblivious to economic issues, particularly as they related to recovery at the sites chosen. Though the military's proposals were generally accepted, there were instances where recommendations were overturned. For example, in 1993, the Air Force's seemingly impartial and objective evaluation of East Coast air mobility wing alternatives concluded McGuire AFB, NJ should revert to reserve status with the remainder of the mission transferring to Plattsburg AFB, NY. Yet, a study by Bernardi (1996) suggests that for no apparent operational or cost rationale, the Commission disregarded this assessment, and recommended Plattsburg close completely while McGuire retain the mission. In another instance, the 1995 BRAC Commission added the huge Air Force maintenance and repair depots at Kelly AFB and McClellan AFB (San Antonio and Sacramento, respectively) to the

closure list contrary to the Pentagon's wishes (Kitfield, 1995). Finally, in an effort to alleviate the layoff fears of some 18,700 federal civilians at Kelly and McClellan, the Pentagon and White House launched a "privatization in place" initiative subsequent to BRAC 95 (*Economist*, 1995). The objective was to preserve jobs for as many employees as possible while transferring ownership of the depot operations to the corporate sector. Ideally, the depot personnel would leave work as civil servants one day, and return the next day as defense contractor employees. Cases like these were exceptions to the rule. But they do suggest that parties on all sides of the BRAC table were not completely insensitive to economic impacts in closure communities.

To explicitly address economic concerns after BRAC recommendations were approved, the Office of Economic Adjustment (OEA) under the Secretary of Defense was charged with facilitating resource conversion and reutilization. In fact, a selling point for a number of closure candidates was that these assets (military land areas and in some cases, structures) could be released to the local government and commercial sectors, to the benefit of the effected communities. As Secretary of Defense William Perry noted in the preface to the *Community Guide to Base Reuse*, "When we must close or cut back one of our military installations, we do it with great regret. But we also do it with great interest in seeing the lands and facilities reborn as new additions to a community's economy, job base and quality of life..." To that end, the OEA has followed the services' preparation of sites for transfer; overseen the marketing of these sites; assisted community leaders in their organization and planning for transition;

administered relief in the form of cash grants; and tracked direct jobs created as a result of these efforts.

As of February 1998, the OEA provided $231 million in grants across the major BRAC locations (GAO, 1998). Though the OEA has held the primary role in reuse, three other federal agencies joined in providing financial assistance to BRAC communities: the Economic Development Administration (EDA), the Department of Labor (DOL), and the Federal Aviation Administration (FAA). Through 1997, these three groups provided another $816 million in cash grants, for a total of $1.047 billion toward relief and reutilization (GAO, 1998).[10] These relief funds are directly tied to BRAC, and tracked accordingly. The CRS claims Congress has provided more than $10 billion in total financial assistance (Siehl, 1996). However, some of the uses actually fall under the broader umbrella of defense draw down relief (e.g., transition assistance for displaced DoD workers, defense industry conversion assistance, etc.).

Additional assistance was provided to BRAC communities in the form of conveyance relief. Specifically, the initial intent of the DoD was to parcel out land and facilities at closed sites to local development authorities for fair market value. The expected revenues were even factored into the cost-benefit analysis submitted to the BRAC Commission, and subsequently included as offsets in the BRAC budgets for facility preparation, cleanup and closure (Brown, 1989;OSD,

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[10] While grants from the other three agencies were spread over most the major BRAC communities to help with reuse planning, infrastructure development, and worker retraining, the FAA's $271 million contribution was targeted to 27 sites which offered benefits like improved air traffic control and decreased route congestion.

1998). However, in response to local civic leaders' complaints about expenses and unduly long delays in transfer, the emphasis shifted from obtaining fair value to expediting the release of these assets (CBO, 1996). For example, in 2000, under Congressional authority, the Air Force is expected to forgive as much as $100 million of the Kelly Greater Development Authority's land conveyance debt for property on the BRAC listed Kelly AFB in San Antonio (*Air Force Times*, 2000).

According to the OEA's *1988, 1991, 1993 and 1995 BRAC Actions Base Reutilization Status* report, through March 1999, new leases and deeds resulting from reuse activity amounted to 1,262 and 124, respectively for the 77 stateside reuse sites tracked. Additionally, post-BRAC reutilization measures generated 53,919 new direct jobs. Federal civilian job losses for these same locations were 135,847. The annual DoD *Distribution of Personnel by State and Selected Locations* reports indicate the corresponding military personnel losses were approximately 196,029. In short, reutilization has generated 1 new direct job for every 6 federal jobs lost.

Empirical Examinations of Closure Impacts

Hooker and Knetter (1999) employ a counterfactual approach to analyzing the impact of base closures, contrasting actual county level employment and PCI growth rates with those that would have occurred (1) had the county measures continued to grow at their respective state's rate; and (2) had the ex post margin between county and state measures mirrored that of the pre-closure period. The

differential is assumed to represent the jobs lost or PCI change as a result of the closures. Ordinary Least Squares (OLS) is used to estimate overall job loss multipliers (the dependent variable being jobs lost under the counterfactual scenarios, and the independent variable being direct defense jobs lost through closures). Establishing τ as a given base's year of closure, a single independent variable regression is run for every combination of the following: employment as the independent variable; the independent variable measured at τ, $\tau+1, \tau+2, \tau+3$, and $\tau+4$; the dependent variable measured under the sustained state growth rate scenario; and the scenario assumed to begin at τ -1, and τ -2 (total of 20 equations). Similar regressions are run for the sustained growth rate differential scenario. In an analogous fashion, PCI change multipliers are also estimated.

The greatest explanatory power is provided in the job loss model, with the counterfactual baseline beginning at $\tau - 2$, under the matching county-state growth rate scenario.[11] All five of the individually estimated coefficients (job loss multipliers) are highly significant and their corresponding models yield R^2 values ranging from 0.46 to 0.63. Of greater interest is that for $\tau = 1$ through 4, the multipliers are between 0.90 and 0.97, and they do not test significantly different

[11] As the authors note, the relatively stronger results under a $\tau - 2$ baseline vs. $\tau - 1$ reinforce the notion that closures were either gradual or anticipated. With respect to counterfactual assumptions, of 57 observations, 22 were lost under the sustained growth rate differential scenario. Based on additional testing, the author's identify potential sample selection problems with this scenario, and therefore suggest the sustained state growth rate scenario is a preferable approach.

from 1 at the five percent level.[12] This implies that for the first four years following closure (and presumably indefinitely thereafter) the only impact is the direct base job loss. Under the τ -1 baseline, the multipliers are even smaller. In either case, since all the estimated multipliers have values less than 1, the results suggest closure county employment actually grew at a faster rate than that of the state, providing "... evidence of indirect or induced job creation!" These findings lend credence to the idea that base closures may present opportunities to local economies in the form of an infrastructure vacuum. It is worth noting Hooker and Knetter test for nonlinear relationships between counterfactual county job loss and base employment loss, finding no evidence of its existence. Furthermore, they obtain an unexpected negative sign from interaction between the shock and a rural dummy variable, but the effect tests insignificant.

Regarding PCI, the authors find closures have little impact. At first glance this seems odd given the other results imply employment losses are restricted to just the direct base jobs lost. Though the military base self-sufficiency argument goes a long way toward balancing these two outcomes, there is still some propensity on the part of base employees to spend downtown. This off-base income is forever lost when the base closes and the employee is transferred. If off-base employment does not change, the region's PCI should decrease --

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[12] At τ =0, $\hat{\beta}$ =0.69 and the hypothesis that $\hat{\beta}$ =1 is rejected at the five percent level. The authors offer no explanation, though it is likely this is because assigned personnel were not relieved of duty en masse on the first day of the reported closure year.

unless the mean PCI for base employees is below that of the surrounding community. This is exactly the reconciliatory explanation offered by Hooker and Knetter. On average the PCI for military members is below that of their civilian neighbors (as much as 1/3 lower). If it is assumed that junior civilian base employees are more apt to out-migrate than their senior peers with stronger ties to the region, the same may be said for these young civil servants who depart the region. This provides a boost to the PCI average for those remaining in the area, offsetting the decrease from lost income.

Hooker and Knetter acknowledge some unresolved issues in their base closure review. Specifically, as noted earlier in this study, assistance provided by the OEA and other government agencies may have had a role in mitigating the effects of defense job losses. In fact, for every six direct jobs lost under BRAC, the OEA takes credit for creation of one new permanent job under its reuse and reutilization efforts (OEA, 1999). The second concern involves the possibility of self-selection bias if regional adaptability was a consideration in the base selection criteria, even if such consideration was not openly acknowledged by the parties involved. However, as they indicate, it is likely any such bias is small given a fair number of bases in "vulnerable" communities were still selected.

Krizan (1998) uses a comprehensive establishment-level panel data set covering all private employment in California (1989-1996) to examine effects of military base employment in that state, at the level they are most expected to occur. Specifically, Krizan models establishment net employment growth rate as a function of net defense personnel changes for bases within defined radii of the

establishment; the ratio of base personnel to local labor force, for bases within 50 miles of the establishment; and, the establishment's age and size. Dummies are included to control for other economic factors (i.e., the establishment's industry classification; the SMSA where the establishment is located; whether the establishment is a single-unit business, or part of a multi-unit company; and, the year of observation).[13] Annual changes in defense personnel levels for all California bases (BRAC *and* non-BRAC) are incorporated in the data set. Establishment-level observations are drawn from the Census Bureau's Standard Statistical Establishment List, which contains comprehensive multi-sector microdata for all lawful concerns having positive payroll. Krizan's final data set was compiled from approximately 4.7 million observations.

In light of the descriptive and limited empirical studies already discussed, the results of Krizan's examination are not surprising. The coefficients for the effects of net base employment changes on establishment growth rates have the expected positive signs, and are significant, but quite small. Specifically, at all the establishment-to-base distances, the change in growth rate per employment change of 1,000 base workers is well under 1%.[14] Included in the regression model is an interaction variable to assess the relative importance of military installations to their local economy (the product of base personnel change and the ratio of base personnel to private sector labor force). At all but the 5 mile

[13] These control dummies are used throughout the analysis. Related details are not presented in the study. However, Krizan does state there are no unexpected patterns in these variables.

radius, the effects are significant, but negative, suggesting private sector employment in rural or small town environments is less likely to contract with base draw downs. As noted, this is counter to the common belief that base closures will have a greater negative impact on smaller communities. It may be that a large share of the rural California communities hosting bases also rely on agriculture as their primary basic activity. Since food exports are not likely to be correlated with local defense activities, production for these agricultural communities should be fairly immune from exogenous base closures.

Krizan also runs a second model that employs the *absolute values* of establishment net growth rates as the dependent variable. The idea here is to measure the degree of "churning," or resource reallocation for business entities potentially effected by base closures.[15] In this variation, the coefficients for base employment changes are also positive and significant, implying churning decreases with drops in base personnel levels. Furthermore, the coefficients diminish with distance. Together, these results suggest the decrease in churning associated with base closures is more pronounced for establishments closest to the bases. To better understand this outcome, Krizan uses probit models to examine establishment births and deaths as a function of the same factors.

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[14] Establishment-to-base distance measures are at 5 mile increments, from 0 to 50 miles. Between 0 and 50 miles, the effects range from 0.0% to 0.6% with no apparent distance-related trend.

[15] In the author's words, churning is "...both expansion and contraction of continuing establishments' employment levels as well as the opening and closing of whole plants. Such transfers of resources can be an essential component of economic growth by facilitating the adoption of new technology ... and enhancing productivity growth through a process of 'creative destruction.'" However, churning also imposes an economic cost in the form of frictional unemployment. This is the cost Krizan is attempting to assess.

Regarding births, the coefficients are positive and decreasing with distance, implying the probability of new births decreases with base personnel losses, particularly closer to the base. Coefficients for the interaction term (base personnel change x ratio of base personnel to private sector labor force) are negative at distances below 40 miles, and positive for greater distances. Together, these results suggest under closure conditions, new births are most likely in smaller military communities, closer to the base.

Results for the establishment deaths probit model are tough to interpret. Only half the coefficients are significant, and the coefficients vary in sign depending on distance. If any conclusion can be drawn, it's that establishments farther away are more likely to close with the installation than are those closer to the base. Calling on the work of Dardia, et. al. (1996), Krizan suggests retirees may help explain this phenomenon. Specifically, military retirees often plant their roots in communities which host bases to take advantage of medical benefits and relatively lower prices at the commissaries and base exchanges (both of which are exempt from collecting state sales taxes). When the base closes, retirees must shift their patronage for these goods and services to the local economy. This helps explain the overall dampened impacts of closures. The role of distance may also be explained, in part, by diminishing housing opportunities close to the base for active duty military members. This is conceivable given the propensity of military retirees to gravitate around bases, and the more permanent nature of the retiree's domicile (i.e., military members typically transfer every 2-3 years). Displaced by a steadily expanding retired

population, the relatively turbulent base workforce gradually accepts longer commutes to work. When the base shuts down and the base employees dissipate, it is the farther reaches of the local area that are most effected. Of course the fact that the OEA actively promotes reutilization of closed defense facilities may also help explain seemingly counterintuitive results related to distance.

When Krizan runs the same models weighted for employment (vs. the establishment orientation), he finds local labor force employment prospects *improve* with base personnel losses (the effect being more pronounced in small towns). Again, the military retiree hypothesis is submitted. To test this hypothesis, Krizan runs the models separately for employment growth rates in the Food Stores SIC, the General Merchandise Stores SIC, and all other non-retail industries combined. For the most part, the coefficients are negative and significant, though the magnitudes are appreciably greater in the two retail SIC's. These results corroborate the shift in patronage theory.

Impact Multipliers and Self-Sufficiency

As noted in a CRS study, "Military bases were often designed to be self sufficient and intentionally separate from the surrounding community" (Siehl, 1996). This self-sufficiency characteristic of military installations tends to limit the indirect and induced impacts of draw downs and closures. In support of this notion, Brauer and Marlin (1992), and Dardia et. al. (1996) hint at factors such as the tendency for active duty military to occupy government provided housing and

consume goods provided through the base, (e.g., recreation service, legal support, organized worship, and health care) at little or no cost to themselves. The composition of the federal civilian workforce is a contributing factor as well. Specifically, veterans receive hiring preferences and prior military experience is often a desirable credential for defense civil service employment. Consequently, some defense civilians also have military retirement benefits entitling them to some of those same on-base privileges.

A simplified example may illustrate in part why military base closure impacts are limited relative to other regional shocks. Think of a military base as a fortress island connected by bridge with its host community. All civilians live on the mainland, while a large portion of the military employees and their families live on the island. Given the availability of low or no cost consumption on-base, military families obtain a substantial portion of their needs on the base, even if they reside on the mainland. Some of the federal civilians have military retiree benefits and therefore obtain a portion of their needs on-base too. The remainder of their needs, and that of all other federal civilians and contractors are met off base. Assume local civilian PCI equals or exceeds that of federal civilians, which equals or exceeds that of military members.[16] The host community's regional employment multipliers for military personnel should be less than those of federal civilians, which should be less than those of defense contractors and all other civilians. This ordinal relationship is reflected in the

[16] Hooker and Knetter (1999) find some support for this assumption about relative incomes.

Pentagon's use of generic rural and urban multipliers to approximate those of military and defense civilian employees: 1.2 and 1.8, respectively (Brauer and Marlin, 1992). Outside researchers have given recognition to this pattern in their multiplier assumptions as well. For example, Lall and Marlin (1992) use 1.2, 1.8, and 2.5 for military, defense civilian, defense contractor multipliers, respectively, in their state-level defense industry impact analysis.

Self sufficiency helps explain in general why military base closure shocks can be expected to be smaller than other regional shocks. But, forecasts of shock-induced growth or decline involve hard numbers, often computed from economic base or regional input-output (I-O) multipliers. Therefore, understanding the favorable differential between actual impacts and what many projected for base closures also requires a look at the assumptions underlying the derivation of these multipliers.

Closures in an Economic Base or Input-Output Framework

In the context of an economic base framework, it is common to view the activities of the military base as wholly basic. This goes back to the public goods concepts of joint consumption, nonexcludability, free-riding, and willingness to pay. Because price will not serve as an effective mechanism for allocating defense, the individual town, county, or MSA by itself has virtually no impact on the demand for defense. Only the collective voice of all communities determines the appropriate level supplied. This collective voice is represented by the federal

government.[17] Hence, from the local community perspective, the demand for national security is generally held to be exogenous, or basic. On the surface, then, the local impact of closing a base is $(b + n)/b$, where b is basic (export driven) industry, n is nonbasic industry, and base employment is a component of b. By way of example, if base employment is 4,000, employment for the remaining basic industry is 6,000, and nonbasic employment is 7,000, the multiplier is $(b + n)/b$ = [(4,000 + 6,000) + 7,000]/(4,000 + 6,000) = 1.7. But this presumes the base consumes nonbasic goods and services in the same proportion as the region's remaining basic industries. There is good reason to believe that is not the case. Specifically, bases typically provide much of their own support, or nonbasic activities, even though these activities are considered basic under the exogenous good of defense. At most bases, these organically provided support activities include, but are not limited to roads, grounds, housing and other infrastructure maintenance services provided through the civil engineering squadron; law enforcement for the base and its residents; operations related warehousing and retail services provided through base supply; hospitals, legal, chapel, and counseling services for military personnel and their families; etc. In contrast, many of these functions are truly nonbasic for off-base industry. As such, actual base-related nonbasic activity should be proportionally less than that suggested by regional economic base multipliers. Intuitively, then, base closure impact estimates derived from regional multipliers are likely overstated –

[17] See Mueller (1996) for a more thorough discussion on collective provisioning of public goods.

in part from use of an inflated multiplier, and in part from its application to an inflated basic shock (recall, the multiplier is applied to the *entire* base employment loss, not just the truly basic portion).

Within the Input-Output (I-O) context, the I-O table design explicitly places military bases in the final demand portion of the table, under the exogenously determined government sector. The effects of changes in this sector (direct effects) on the endogenous interindustry and household sectors (indirect and induced effects) are the subject of base closure impact analysis. Specifically, besides the employment of base personnel, the base has an indirect impact on the local economy through local base contracts and purchases, and an induced impact through the local spending of household income generated from the direct and indirect jobs. Being exogenously determined, the direct effect is given: it is the number of military and federal civilian positions removed through realignment or closure. It is the indirect and induced effects that must be estimated.

Existing I-O tables focus primarily on the interregional relationships, interindustry dependencies and household demand. Defense operations are only broadly addressed in the exogenous government sector, if at all. In practice, multipliers are developed by either fitting military bases into the economic base framework (potential pitfalls already discussed), or *piggybacking* on existing I-O industry multipliers to meet current needs. As an example of the latter, analysis guidelines under the most recent BRAC round required the use of standardized multipliers adapted from the Bureau of Economic Analysis (BEA) produced

Regional Input-Output Modeling System (RIMS II).[18] In essence, multipliers for the "general" installations and the "specialized" bases categorized as depots, research and development bases, and ammunition production facilities were empirically *inferred* from a cross-section of multipliers for SIC "equivalents," across 53 regions. Because the objective was to develop a consistent cost analysis approach that did not understate impacts, the guidance acknowledges that the underlying assumptions result in multipliers that intentionally overstate impacts.[19] However, even correcting for these assumptions, gross impact estimates are likely to be overstated for reasons analogous to those discussed under base closures in an economic base framework. Specifically, in any study founded on analogy, it may be a stretch to presuppose privately owned enterprises exact the same indirect and induced effects on the local economy as "similar" government run operations. Consider the Air Force depot which by analogy is probably best approximated by the aircraft and aircraft parts manufacturing SICs. Certainly, the core operations are very similar. Both groups buy, manufacture, distribute, repair, and service aircraft or aircraft components. But in reality, the aircraft SIC multipliers are likely to be higher than those of their government brothers because, once again, bases typically provide much of their

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[18] Guidelines and an overview of multiplier derivation are contained in the *Economic Impact Database, 1995 Base Realignment and Closure* (1995).

[19] For example, base related induced consumption is assumed to be permanently removed when the base closes. However, some displaced workers find employment locally, and still others retire in the area and continue spending. For these individuals, local off-base services take the place of services previously obtained through the base (e.g., health care). Assumptions regarding the equation used to fit the data, and explicit upward adjustments to the estimated multipliers are also sources of impact overestimation under this particular guidance. In short, the

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own support, or "indirect" activities, even though these activities are considered "direct" along with the core function of the base for regional I-O purposes. So when a depot shuts down, the vehicle fuels section of supply and the chaplain's staff are counted as direct impacts, yet off base their equivalents are indirect and induced losses if Lockheed downsizes. To exacerbate this disconnect, when the larger private industry based multiplier is applied to the depot, it is applied to an inflated base that includes medical support, law enforcement, the vehicle fuels section, the chaplain, and many others.

The implications of economic base and I-O approaches to base closure impact analysis are evident in the disparity between actual and projected impacts. When bases were under review for inclusion in the various BRAC rounds, impact projections forwarded to the committee were often gloomy, if not catastrophic. As Dardia (1996) suggests, a number of these estimates may have been tainted since they were conducted under grassroots efforts to lobby against closure. But, even given the benefit of the doubt, it is likely local analysts employed some form of economic base factor or adapted I-O multiplier. And, as the examples above illustrate, there is a strong possibility even the most objective of studies included inappropriate multipliers, appropriate multipliers applied to the wrong base, or both. Other than cases of simple neglect or arbitrary speculation, it is difficult to conceive of a scenario where any one of these oversights could produce a downward biased impact estimate. Yet, given

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resulting I-O multipliers generate relative vulnerability indices rather than true impact assessments.

that actual impacts were lower than most anticipated, the development and application of upward biased multipliers is not only possible, but likely.

Infrastructure's Role in Limiting Impacts

The descriptive and empirical studies reviewed thus far allude to industry's reuse of freed public resources, both on and off base, as a possible explanation for better than expected post-BRAC regional economies. Recent findings in the fiscal policy field also support the idea that reutilization opportunities in the form of idle public infrastructure may have a significant role in mitigating the impacts of base closures. Specifically, fiscal policy studies often focus on determining if a causal relationship can be established between public goods provisioning and regional growth. There are two principal reasons why such a relationship may exist. From the individual's perspective, public goods may serve as amenities that entice inmigration.[20] From the view of the firm, economies of scale under public provisioning may translate to low cost factors of production (e.g., water delivery, sewer and waste removal, highways and ports for shipping, etc). In either context, the base closure and reuse process may be viewed as surrogate public expenditures. In a reutilization capacity, the bases represent an injection of ready- or near ready-to-use infrastructure; from roads and grounds, to utilities, telecommunications, plant and equipment. Furthermore, when a base population vacates, a public goods vacuum is created in the surrounding communities which

provided the schools, police and fire protection, developed residential areas, highways, and public utilities necessary to host their DoD neighbors. Therefore, if BRAC did not invoke severe hardship on local communities as studies seem to indicate, the fiscal policy literature may offer some useful insight into why this may be the case.

In a study of local economies, Eberts (1991) empirically examines the role of publicly provided infrastructure in promoting metropolitan economic growth. By breaking down public expenditure into the categories of new investment (i.e., additions to capital stock) and maintenance of existing public capital, he develops support for the intuitive notion that it is new investment in infrastructure, and not gross public expenditures that spurs growth. From the amenity and marginal productivity standpoint, it may be that increased public capital stock per capita is a necessary condition for promoting employment growth. Empirically, Eberts finds support for this conclusion. He also finds public expenditures to sustain existing infrastructure are not significantly correlated with regional growth. This presents a dilemma for many communities. Since local budgets are constrained, they must balance their need to arrest or slow the deterioration of existing infrastructure with their need to build for tomorrow's economic growth. In older communities, the more immediate need for sustainment often wins out. For example, Eberts notes that in 1985 only two cents of every public dollar expended on Cleveland's infrastructure actually went toward new capital.

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[20] For example, Herzog and Schlottmann (1986) find recreational features, low crime rates, and accessibility to educational opportunities are significant migration determinants.

Though residents may prefer the improved economic conditions growth offers, efforts to increase the *new investment* vs. *sustainment* ratio meet resistance since these measures come as a sacrifice or an added expense to those same residents. However, as suggested above, military base reuse may represent a low or no cost alternative to new investment.

Fox and Murray (1991) explore the effects of sub-state fiscal policies on industry dynamics, focusing on new entries or growth in existing businesses related to local public revenue structure, expenditure patterns, and infrastructure. They find that specific changes to tax rates and expenditures have little impact on firm startups and location decisions in the near-term. It is only through the long run impact of a variety of policies that local governments can hope to see enhanced economic growth. Though economic climate and the cost of labor and transportation overshadow local revenue and expenditure policy as firm entry determinants, infrastructure and education are identified as two public sector vehicles with potential to significantly impact development. Again, freed resources under base closures may approximate new spending in either or both these areas.

Papke's 1991 examination of industry responsiveness to state tax differentials finds that industry location decisions are influenced by these differences at the state level. Specifically, taxes have the expected inverse relationship with both business starts and expansions. More importantly, from the provisioning side she concludes the location decision for some industries appears to be positively influenced by differences in public expenditures. These

findings suggest new infrastructure with little or no new accompanying expenditure should result in favorable conditions for regional growth.

Dalenberg and Partridge (1995) explicitly address the twofold impact of infrastructure on employment discussed earlier: as an amenity to workers (and firms), and as an unpaid input in the production process. At the MSA level, they find that revenue and expenditure policies significantly influence total employment levels. In particular, both lower taxes and increased expenditures on public education have positive effects on employment growth.

When Dalenberg et. al. (1998) revisit the role of infrastructure in regional employment growth, they attempt to corroborate or counter the findings of recent state-level research, which suggests that public capital has little influence on output. They find flaws with previous studies that use production function or cost function approaches to measure the effects of public spending on output. Inherent problems with these approaches include difficulties measuring state output; nonexistence of state-level price deflators; potential for inputs and outputs to be model driven; accounting for spillover effects; inability to capture indirect effects (e.g., infrastructure as a paid/unpaid production input; as an amenity that attracts workers; and as a synergistic effect on the productivity of other inputs); etc. To address these concerns, Dalenberg and company look at the direct effect of infrastructure on employment. Some distinct advantages of this angle include enhanced reliability of data; absence of the need to normalize prices; and ability to control for varying state characteristics (e.g., demographics, industry structure, and noninfrastructure amenities). The study considers both highway

expenditures, and public spending net of highway expenditures vs. changes in employment. In both cases a significant positive relationship is evident.[21]

Finally, in an effort to explain the outmigration of manufacturing from the "Rust Belt" to the South, Crandall (1993) attributes most of the shift to wage differentials and the degree of unionization. However, he also identifies infrastructure as having a significant influence during the period 1977 through 1989. Regarding policy prescriptions to ease the losses from the North, his work suggests public capital may have a valid role to play in workforce and industrial retention.

The implication of the preceding studies is that reutilization potential may be a mitigating factor in the impact of base closures on local economies. Just like new public goods expenditures, freed up public capital can be an amenity or a factor of production that promotes inmigration and regional growth. As an obvious example, consider the closure of a base with an operable airfield, like Chanute AFB in Springfield, IL. In a municipal capacity, the airport offers many attractive features, to include freight handling and movement, transportation convenience, access to markets, and relief to already congested airports and routes servicing neighboring communities. Even the less obvious examples of installations with little more than land to offer represent reuse potential in the form of public parks and recreation areas.

[21] With regard to production and cost function approaches to examining infrastructure's role, Dalenberg et. al. (1998, p. 46) attribute the differences in results to the failure of those techniques

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Defense Dynamics and Labor Redistribution

County level effects of base realignments and closures, or defense downsizing in general, may be less than disastrous or even beneficial when one considers defense accession and attrition dynamics. Specifically, only one of six counties in the United States has a defense presence. Excluding counties with less than 300 defense employees, this number drops to one in nine. During periods of defense expansion, these 348 counties draw defense workers, or recruits from across all 3,092 counties nationwide. Granted, defense counties likely contribute a greater than average share of this labor since the local installations serve to influence potential military recruits and offer nearby employment to prospective civil servants. But even so, a substantial percentage of DoD employees are recruited from outside defense counties. Many of these individuals do not return to their original home of record when they leave service. Given the psychic costs related to job search and relocation, a fair number remain in the area of their last duty station and assimilate into the local labor force. This is especially true in an era of outsourcing and privatizing, when former defense employees find their skills are highly valued and sought after locally. What's more, military retirees generally exhibit a trend of settling near installations to take advantage of base related benefits as they begin second careers. In short, defense business cycles serve to redistribute the supply of private labor. The result is often supply driven regional growth.

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to recognize the "...amenity role of public infrastructure in attracting capital and labor."

Chapter III

METHOD OF ANALYSIS

Impact Model Design

An empirical regression based approach is used to test anticipated relationships against a panel data set spanning 1978 through 1997. County level non-farm private industry employment is the dependent variable.[22] The independent variables include defense personnel levels for all stateside installations (BRAC and non-BRAC) plus related characteristics, and peripheral regional factors, or control variables that influence county-level employment. The defense variables are the central focus of the study, and they are modeled as the *direct effects,* or exogenously determined employment changes, congruent with views held in practice. In using private employment as the left-hand side variable, only the *indirect effects* of military base employment changes are captured in this figure. The results yield multipliers that differ somewhat from those obtained through analogy and adaptation of existing industry data, but the methodology is more defensible. The results of this study complement the

[22] Appendix A contains a variation of the final model of this study, where the dependent variable is per capita income rather than employment.

findings in Krizan's 1998 longitudinal study, which was confined to modeling realignment impacts in California only.

Levels and *Changes* Dynamic Models of Employment Impact

Causal analysis of regional employment as a function of local military employment can be examined with the change in regional employment as a function of the change in military employment (the "Changes" model). It can also be modeled with the change in regional employment as some function of the level of military employment (the "Levels" model). Finally, it can be modeled with the level of regional employment as a function of the level of military employment (the "Levels/Levels" model). In the case of a dynamic model, with a lagged dependent variable, the "Levels" and the "Levels/Levels" models yield the same estimates since both forms minimize the same prediction error. As such, this study narrows the choice to that of a "Changes" or a "Levels/Levels" model (herein referred to as *Changes* and *Levels*, respectively). Bartik (1991) presents a good review of the relative merits of these two techniques. Basically, the appeal of the *Changes* approach lies in its ability to mitigate concerns with omitted variable bias when it comes to time-invariant factors difficult to measure or quantify, but believed to have a significant effect on the dependent variable (e.g., community or firm *espirit de corps* as it relates to output). In essence, since the *Changes* model involves first differencing both sides of the model, these troublesome but constant fixed effects fall out of the equation. Consequently, their intentional or overlooked omission from the model is a moot

point. On the other hand, first differencing also removes a lot of information regarding actual variation in the observed variables, without a commensurate reduction in the overall measurement error. In other words, when measurement error is possible or likely, the *Changes* model will reflect a higher ratio of measurement error to true variance, resulting in a greater bias. But, as Baltagi (1995) notes, an advantage of panel data is that it lessens these concerns given the additional cross-sectional dimension for reflecting variation in variables.

Both the *Levels* and the *Changes* approaches are examined for suitability in modeling the research propositions. Because the *Levels* technique is particularly sensitive to omitted variables, and the data available may not capture all the factors that effect local private employment, the results generated from the *Changes* model are arguably more meaningful. Furthermore, as discussed subsequently, only the *Changes* form of the model allows examination of proposition (2).

General Specification

The general form of the model is $EMP_{jt} = f(\mathbf{D}_{jt}, \mathbf{N}_t, \mathbf{M}_{jt}, \mathbf{I}_{jt})$, where EMP_{jt} is non-farm private industry employment for county j, in time t; $\mathbf{D}_{jt}$ is local defense employment characteristics; $\mathbf{N}_t$ represents national level economic influences; $\mathbf{M}_{jt}$ includes migration determinants; and $\mathbf{I}_{jt}$ is industry location factors. $\mathbf{D}_{jt}$ is comprised of the primary variables of interest in the study, while $\mathbf{N}_{jt}$, $\mathbf{M}_{jt}$, and $\mathbf{I}_{jt}$

make up the control variables. Consistent with the public finance literature, $\mathbf{D}_{jt}$ is held to be exogenously determined.[23]

Beginning with the *Levels* modeling approach, define long run equilibrium private employment, EMP_{jt}^*, to be a function of $\mathbf{D}$ and $\mathbf{C}$:

$$EMP_{jt}^* = \beta'\mathbf{D}_{jt} + \gamma'\mathbf{C}_{jt} \tag{1}$$

Again, $\mathbf{D}_{jt}$ is the vector of characteristics related to defense installations and their labor forces; $\mathbf{C}_{jt} = f(\mathbf{N}_t, \mathbf{M}_{jt}, \mathbf{I}_{jt})$.

The baseline model incorporates a dynamic specification whereby actual regional employment, EMP_{jt} is a function of long run equilibrium employment EMP_{jt}^* and lagged employment, $EMP_{j,t-1}$. The lagged dependent variable is consistent with Finkel (1995), because the present state of regional employment is believed to be determined in part by the past state, rather than "created anew." It also supports the desired partial adjustment setting and will provide some gauge of regional size in the *Changes* model. In *Levels* form, the dynamic model, then, is:

$$EMP_{jt} = \lambda EMP_{jt}^* + (1 - \lambda)EMP_{j,t-1} + \varepsilon_{jt} \tag{2}$$

$$0 \le \lambda \le 1$$

[23] See discussion of military bases in an I-O and economic base framework, beginning on page

(continued on next page)

Substitution of (1) in (2) yields:

$$EMP_{jt} = \lambda\boldsymbol{\beta}'\mathbf{D}_{jt} + \lambda\boldsymbol{\gamma}'\mathbf{C}_{jt} + (1-\lambda)EMP_{jt-1} + \varepsilon_{jt} \tag{3}$$

This is the classical form of the general model to be estimated. It is possible the disturbance may be time and/or region sensitive. Assuming the disturbance is dependent in part on both dimensions, the three error component (two-way) specification of the error term will accommodate this view:

$$\varepsilon_{jt} = u_t + v_j + w_{jt} \tag{4}$$

Substitution of (4) into (3) yields:

$$EMP_{jt} = \lambda\boldsymbol{\beta}'\mathbf{D}_{jt} + \lambda\boldsymbol{\gamma}'\mathbf{C}_{jt} + (1-\lambda)EMP_{jt-1} + u_t + v_j + w_{jt} \tag{5}$$

This is the *random effects* form of the general model to be estimated. The Breusch-Pagan Lagrange Multiplier test, as described in Kmenta (1997), is used to test the hypothesis H_0: $\sigma_u^2 = \sigma_v^2 = 0$, in which case the model in (5) defaults back to the classical model in (3) as the appropriate choice of the two.

Should the null hypothesis be rejected, it is still possible that (5) is not the appropriate specification. Specifically, it may be the case that one or more of the

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33, and Mueller (1996).

explanatory variables in $\mathbf{C}_{jt}$ or $\mathbf{D}_{jt}$ is correlated with u_t and/or v_j. For example, v_j captures all the region related error – both true error, and error attributable to unobserved or unmeasured region unique factors. Suppose climate – a characteristic unique to regions, but relatively constant over time – is one of those unmeasured factors, and population is one of the explanatory variables. Intuitively, population is correlated with climate, but climate is omitted from the model, so the estimates will be biased and inconsistent. A region dummy variable can be used to capture the combined influence of climate and other unobserved region specific and time-invariant characteristics. The effects of these unobserved factors are then estimated as parameters rather than being rolled into the error terms. A parallel solution applies to unobserved factors that differ across time, but remain constant across regions.

Allowing for the consideration of time *and* region specific fixed effects, the model in (3) can be expressed as:

$$EMP_{jt} = \Lambda_t + \Psi_j + \lambda\boldsymbol{\beta}'\mathbf{D}_{jt} + \lambda\boldsymbol{\gamma}'\mathbf{C}_{jt} + (1 - \lambda)EMP_{jt-1} + \varepsilon_{jt} \qquad (6)$$

Equation (6) is the *fixed effects* variation of the model estimated.[24] Λ_t is used to capture unobserved/unmeasured region-invariant fixed effects, while Ψ_j captures the unobserved/unmeasured time-invariant fixed effects.

[24] Equation (6) assumes both region and period fixed effects. It is also possible that fixed effects prevail only across regions, or only across time, rather than both. In either case, a two error component hybrid of equations (5) and (6) is appropriate.

Assuming the null hypothesis for the model in (5) is rejected – ruling out the classical model in (3) – the Hausman test, as described in Greene (2000), facilitates testing for correlation between the explanatory variables and the error terms. If a relationship exists, the *fixed effects* model described by equation (6) is the appropriate specification. If the correlation is not significantly different from 0, the *random effects* model presented in (5) is appropriate.

Should the Hausman test point to the *random effects* model as the appropriate specification, inherent difficulties with the lagged dependent variable have to be addressed. Specifically, as illustrated in equation (5), EMP_{jt} is a function of v_j and $EMP_{j,t-1}$. But this means $EMP_{j,t-1}$ is also a function of v_j, which is a violation of the least squares assumption that right side variables are independent of the error term. Instrumental variable techniques are typically necessary to preclude the biased estimates that result. For example, under the *Changes* model, techniques suggested by Baltagi (1995) and Anderson and Hsiao (1981) are applied. Specifically, $(EMP_{j,t-2} - EMP_{j,t-3})$ and $EMP_{j,t-2}$ are examined for suitability as instruments for $(EMP_{j,t-1} - EMP_{j,t-2})$.

Equations (1) through (6) may be converted to the *Changes* format simply by taking the first differences. To illustrate, the *Changes* general form of the *random effects* model in (5) is:

$$EMP_{jt} - EMP_{j,t-1} = \qquad (7)$$

$$\lambda\boldsymbol{\beta}'(\mathbf{D}_{jt} - \mathbf{D}_{j,t-1}) + \lambda\boldsymbol{\gamma}'(\mathbf{C}_{jt} - \mathbf{C}_{j,t-1})$$

$$+ (1 - \lambda)(EMP_{jt-1} - EMP_{j,t-2}) + (u_t - u_{t-1}) + (v_j - v_j) + (w_{jt} - w_{j,t-1})$$

Note that the region related component of the error term, $(v_j - v_j)$, reduces to 0, thereby dropping out of the model.

Explanatory Variables and Expected Relationships

Given $\mathbf{D}_{jt}$ is the vector of observed characteristics of defense installations and their labor forces, the variables chosen to reflect these characteristics in the *Levels* form of the model are listed in Table 1.

DEF_{jt} is self-explanatory. As proxy for BRAC facilities reuse, $LAND_{jt}$ is an approximation of actual installation land reuse. It is based on the total acreage "excessed" as of November 2000, allocated across time in proportion to base personnel losses following the corresponding BRAC round.

Referring back to equations (6) or (7), $\mathbf{C}_{jt}$ is the vector of observed characteristics which impact regional employment, other than local military presence. More specifically, $\mathbf{C}_{jt} = f(\mathbf{N}_t, \mathbf{M}_{jt}, \mathbf{I}_{jt})$ represents the underlying economic environment in which the exogenous military shocks perform. Failure

Table 1 – Defense Related Variables

Variable	Definition
DEF_{jt}	Military and defense federal civilian employment.
$LAND_{jt}$	Proxy for *cumulative* BRAC facilities reuse, measured in acres (i.e., $LAND_t + LAND_{t-1} + LAND_{t-2} + \ldots$).

Notes: 1. Measures are at the county level
2. j denotes county j
3. t denotes year t

to adequately consider these control factors may lead to omitted variable bias in the results of the analysis.[25]

Regarding the national level control variables, $\mathbf{N}_t$, a number of possibilities exist for capturing these effects. For example, Hamilton (1983) finds compelling evidence that crude oil price shocks are correlated with, and possibly precursors to U.S. recessions. Specifically, for the period 1945-1981, seven of the eight post-war recessions were preceded by significant increases in the price of oil (typically a ¾ year lag), yet the case for coincidence or a causal relationship between another endogenous factor and both happenings is not evident. Hooker and Knetter (1997) find added support for the use of oil prices as macroeconomic control variables. But, given the economic inertia at the national level, perhaps the most appropriate approach is to control for these influences through the use of period dummy variables (a period fixed effects specification). It may be difficult to argue that other proxies or combinations of measures offer a more comprehensive representation of national factors.

The effects of crude oil prices evidenced in Hamilton's work, and that of Keane (1993), suggest oil related factors may have a role elsewhere in the model. Specifically, state-level composite energy prices, which are highly correlated with crude oil prices, may be useful proxies of relative living and production costs. Hence, this explanatory variable has potential in the modeling

[25] As noted by Bartik (1991), the "Changes" form of the model offers some relief to this condition.

of both migration and industry location factors. In either case, the expected relationship with regional employment is negative.

The vector of control variables, $\mathbf{C}_{jt}$, is also comprised of migration determinants, $\mathbf{M}_{jt}$. A common theme in regional studies is that employment opportunity and amenities are significant determinants of migration. For example, Greenwood (1969) finds unemployment rates at the origin are a significant factor in the decision to migrate. Schlottmann and Herzog (1982) find the probability of outmigration increases with the population-employment pressure index.[26] Knapp and Graves (1989) sketch theoretical frameworks that have roles for location specific amenities under both supply and demand driven migration and regional development models. Other empirical works (e.g., Herzog and Schlottmann,1986; Clark and Knapp, 1995) further reinforce the importance of disamenity and quality of life considerations, and employment opportunities in the migration decision. As such, a lagged population pressure index is included.[27] This variable serves as a proxy for employment potential and economic assistance. Ceteris paribus, higher ratios for past index values signal unfilled demand, a ripe labor market, and possibly the need for jobs programs and other public assistance in the current period. The expectation is that regional employment increases with the *lagged* value of the population-to-employment ratio. At first glance, this may seem contrary to results of Schlottmann and

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[26] The population-employment pressure index is defined as those who can work divided by those who do work (i.e., population 14 years of age or older over total employment).
[27] The population pressure index used in this study is defined as total population divided by total employment.

Herzog (1982). But the two ideas can be reconciled. Specifically, higher population-employment pressure indices in the current period indicate either labor force participation is low, or unemployment is high. In the latter case, the immediate response may be an increased propensity to migrate out, as Schlottmann and Herzog suggest. This offers some relief to the population pressure index via a reduction in the numerator. But, from the supply side, high index values – whether due to lower participation or higher unemployment – also characterize untapped labor, and may even signal planners and government officials that assistance is required. The resulting downstream attention acts as a counterforce, generating jobs and increasing the denominator of the index. As the lagged index decreases in value, this effect diminishes. To assume the opposite (i.e., that employment *decreases* as the lagged population pressure index increases) might suggest depressed areas generally stagnate, and then wither away. While there is a wealth of evidence to support the idea of regional employment cycles, actual instances of modern ghost towns are few and far between.

As discussed previously, Dalenberg, et. al. (1998) find public goods expenditures are positively related to employment. Since employment opportunities influence the migration decision, the model incorporates a variable to capture this effect. Specifically, state and local government employment is used as a proxy for regional public goods expenditures. Intuitively, the former should be a good substitute for the latter as the two are generally highly correlated.

While most agree transfer payments offer no benefits in the form of macroeconomic growth, some may argue the resulting increased spending has induced employment effects at the local levels, where payments are received. However, transfer payments are also indicative of local economic conditions and, perhaps, the state of the local labor force. In this model, it is assumed the latter negative relationship outweighs the former positive effects of induced employment, such that income maintenance benefit payments are considered a disamenity with respect to the migration decision. The model captures the effect of this disamenity on migration, and hence employment, in the form of a lagged per capita income maintenance benefit payments variable.

The intangible amenities side of migration determinants may be modeled through regional dummy variables. In modeling county level growth, Carlino and Mills (1987), find Census region dummies serve as good proxies for important regional amenities. However, preliminary tests reveal group fixed effects, or county level dummies add more power to the models that follow despite the resulting loss in degrees of freedom. Accordingly, county level dummy variables are examined against the random effects model form to evaluate their overall suitability in capturing the effects of unobservable amenities.

Finally, the vector of control variables, $\mathbf{C}_{jt}$, includes industry location factors, $\mathbf{I}_{jt}$. The literature is fairly consistent in the idea that investment in human capital, or education, exacts a positive influence on industry location, and hence economic growth. For example, Wasylenko and McGuire (1985) find education expenditures have a significant positive relationship with employment in the retail

trade and finance industries, and overall state employment. Plaut and Pluta (1983) report education expenditures are a significant determinant of manufacturing employment growth. According to Helms' 1985 panel data study, state revenues applied to public education programs enhance state output. Recognizing that wages are highly correlated with education levels, a lagged private wage rate variable is included as a proxy of regional education levels. Per capita federal education assistance is also used to reflect improvements to local human capital. Both capture education's role in industry location, and hence employment growth. Given education's potential at improving individual earnings and well being, it is conceivable to think of these factors as favorable migration determinants as well.

Keeping with conventional thought, and Blomquist's (1988) specification of the indirect utility function for households in his study of industry location under cost minimization and household utility maximization criteria, household utility is inversely related to land rents within the region. Under monocentric models of land rents (see Muth, 1985), these rents can be expected to increase as one approaches the geographic urban center, or central business district. This stands to reason as population density increases in that direction and land becomes scarce. In that light, population density may be viewed as a disamenity in the migration decision. However, density is also indicative of cultural, social, and recreational opportunities, which are typically regarded as amenities. So, with respect to migration determinants, the effect of population density is unclear. But as Smith (1971) notes, large cities and metropolitan areas offer well-

developed infrastructure, education institutions, services not available in smaller places, and agglomeration economies. Accordingly, urbanization, as reflected in population density is a favorable industry location factor. In this model, it is treated as such and this positive effect is assumed to outweigh the negative consequences of higher rents and congestion. The lagged value of population per acre is the specific variable used. Its expected positive relationship with employment is congruent with the results of Herzog's and Schlottmann's 1993 study which finds that for most metropolitan areas (i.e., those below 4.4 million in population), population functions as a net-amenity.

Regarding industry structure, examination of Figure 4 reveals a consistent trend in the manufacturing and service industry sectors during the sample period. Specifically, as a percentage of total U.S. employment, manufacturing has sharply declined over these twenty years while the service industry has boomed. As such, the set of industry location control variables includes variables that capitalize on this obvious structural shift. In the spirit of shift-share analysis, regional employment growth related to the industry mix effect is captured through variables that reflect the region's industry structure for the preceding period. Variables depicting relative industry representation (e.g., EMP_{ij}/EMP_j) are well suited for this role. Of course, for the n industries comprising the structure being modeled, only n-1 such variables can be used or they will all sum to one, resulting in collinear regressors.

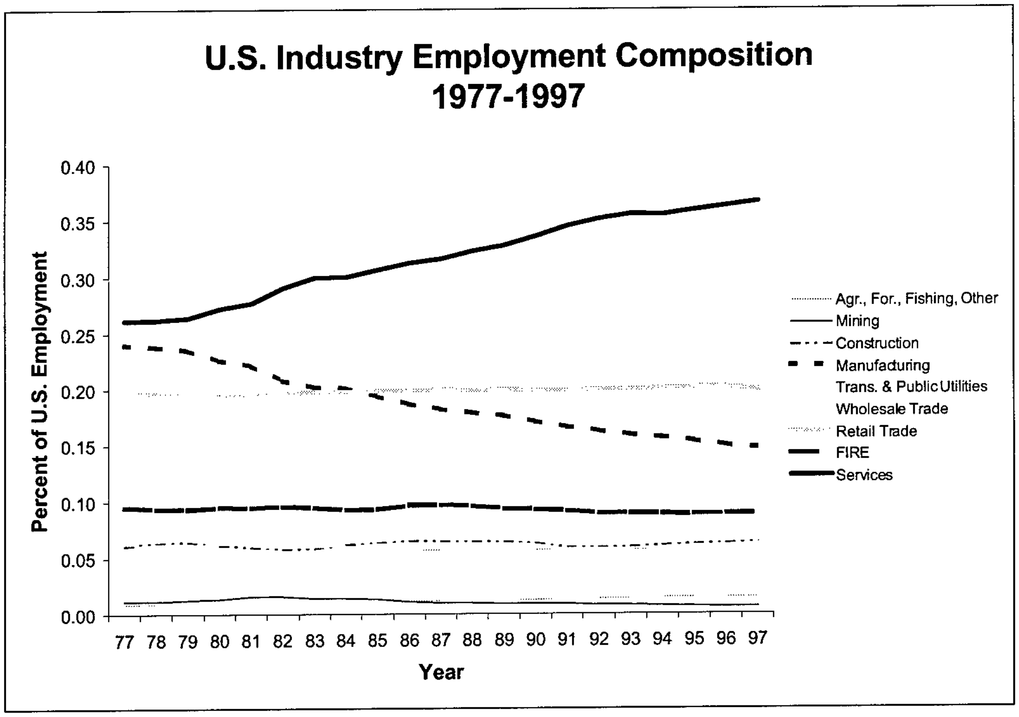

Figure 4 - Industry Employment Composition

The nominal levels of industry employment illustrated in Figure 5 provide some insight into the appropriate choice for the industry structure variables. Though manufacturing has radically dropped as a percent of U.S. employment, growth-wise it has only declined 3.5 percent during this same period. On the other hand, services has grown 120 percent while the remaining non-farm private sectors have more or less moved together, growing 53 percent when viewed in aggregate. Therefore, lagged values of *percent services* and *percent other private employment* (i.e., aggregate non-farm private employment other than services and manufacturing) are included to modeling regional industry structure effects.

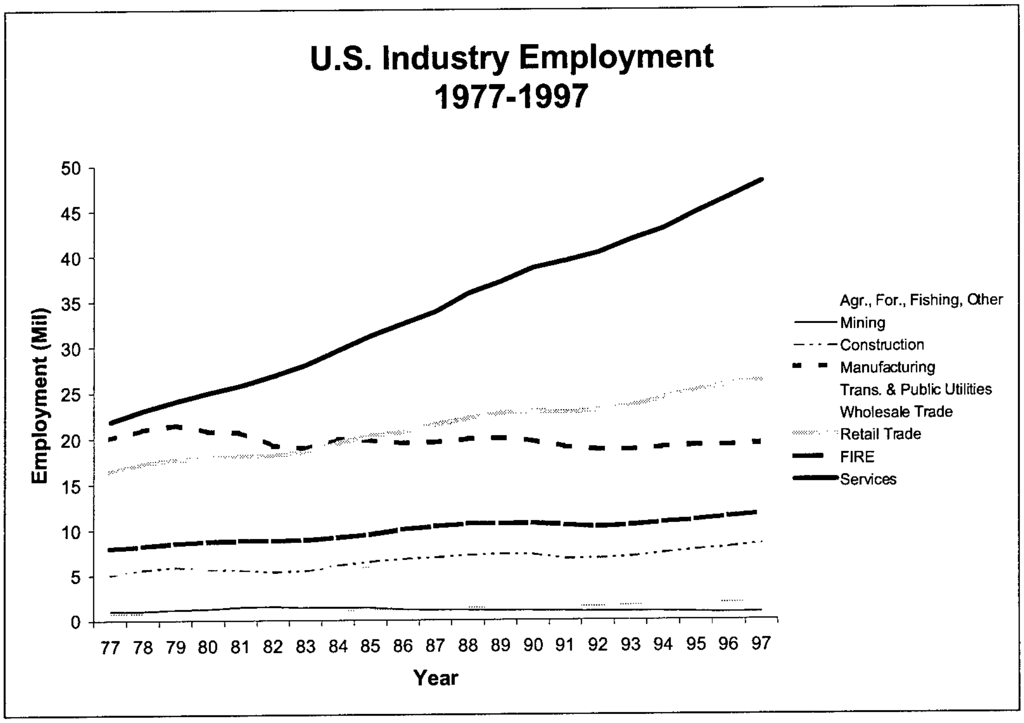

Figure 5 - Industry Employment Levels

Economic base theory suggests resilience to exogenous regional shocks may be determined in part by the community's degree of industry specialization. Specifically, the more specialized a county becomes, the more likely it is producing for demands beyond its own internal consumption. As this ratio of basic to nonbasic industry grows, the effects of exogenous shocks such as local military draw downs and base closures are less pronounced. For example, defense workers stationed in a county that is highly specialized in agriculture may have to satisfy a greater portion of their consumer demands through imports (e.g., catalogs, mail order, shopping excursions, etc.). When these workers depart, the loss of this consumption has little or no effect on the host community.

Of course this dampening effect applies in the case of defense buildups as well. To model this effect, a lagged coefficient of specialization variable is interacted with the defense personnel variables in an appended variation of the *Changes* model. The expectation is that increased specialization reduces the effect of the primary defense variables. The coefficient of specialization is also included as a stand-alone variable to preclude erroneous acceptance of the interaction term as significant if the specialization coefficient alone is in fact carrying the *explanatory weight*. The *Levels* model does not include a coefficient of specialization interaction term, as this term cannot be literally transformed to a *Changes* form with any economic meaning. It does, however, contain a stand-alone industry specialization variable, because even by itself it is expected to have a role in determining regional employment growth. Specifically, the coefficient of specialization is expected to have a negative relationship with employment; as industry composition becomes more specialized, employment growth is retarded. The thought here is that much like a stock portfolio, over time the diverse regional structures are subject to less industry specific risk, and therefore realize more stable growth patterns.[28]

Finally, $\mathbf{I}_{jt}$ would not be complete without consideration of the exogenously determined factor, farm employment. Like defense, the bulk of demand for this industry's output originates from beyond county lines. Though the purpose of this study is to examine defense employment effects on local communities,

[28] Much work has been done in this area. For instance, see Kurre and Woodruff III (1995).

failure to consider farm employment would probably result in omitted variable bias; particularly since positive indirect and induced employment relationships are expected between farm employment and private employment. The specific variables incorporated in the $\mathbf{C}_{jt}$ vector of control variables for the *Levels* model are summarized in Table 2.

Algebraically, the preliminary specification of the model in *Levels*, random effects form is reflected in equation (8). Expected signs are given.

$$
\begin{array}{lll}
EMP_{jt} = \alpha & & \\
\quad + \lambda\beta_1 DEF_{jt} & \lambda\beta_1 & > 0 \\
\quad + \lambda\beta_2 LAND_{jt} & \lambda\beta_2 & > 0 \\
\quad + \lambda\gamma_1 STNRGY_{j,t-1} & \lambda\gamma_1 & < 0 \\
\quad + \lambda\gamma_2 PPI_{j,t-1} & \lambda\gamma_2 & > 0 \\
\quad + \lambda\gamma_3 SLG_{jt} & \lambda\gamma_3 & > 0 \\
\quad + \lambda\gamma_4 PCIMBP_{j,t-1} & \lambda\gamma_4 & < 0 \\
\quad + \lambda\gamma_5 PWR_{j,t-1} & \lambda\gamma_5 & > 0 \\
\quad + \lambda\gamma_6 PCFEA_{j,t-1} & \lambda\gamma_6 & > 0 \\
\quad + \lambda\gamma_7 DNSITY_{j,t-1} & \lambda\gamma_7 & > 0 \\
\quad + \lambda\gamma_8 PSRVC_{j,t-1} & \lambda\gamma_8 & > 0 \\
\quad + \lambda\gamma_9 POPE_{j,t-1} & \lambda\gamma_9 & > 0 \\
\quad + \lambda\gamma_{10} CS_{j,t-1} & \lambda\gamma_{10} & < 0 \\
\quad + \lambda\gamma_{11} FARM_{jt} & \lambda\gamma_{11} & > 0 \\
\quad + (1-\lambda) EMP_{j,t-1} & (1-\lambda) & > 0 \\
\quad + u_t + v_j + w_{jt} & &
\end{array}
\tag{8}
$$

Note that this initial specification facilitates testing of propositions (1) and (3). Specifically, proposition (3) holds that military base reutilization efforts create local employment. Since LAND is the proxy for cumulative facilities reuse under BRAC, this is modeled in the expectation that $\partial EMP/\partial LAND = \lambda\beta_2 > 0$. The expectation that $\partial EMP/\partial DEF = \lambda\beta_1 > 0$, appears to say defense workforce levels exhibit a positive relationship with local employment. Congruent with

Table 2 – *Levels* Model Control Variables

Variable	Definition
$STNRGY_{j,t-1}$	State level composite cost of energy (\$/million BTU); proxy for relative cost of living/cost of production; lagged one period.
$PPI_{j,t-1}$	Population Pressure Index (population/non-farm private employment); lagged one period.
SLG_{jt}	State and Local Government employment in year t.
$PCIMBP_{j,t-1}$	Per Capita Income Maintenance Benefit Payments; lagged one period.
$PWR_{j,t-1}$	Private Wage Rate (private industry earnings/private industry employment); (\$000); proxy for workforce skills/education level; lagged one period.
$PCFEA_{j,t-1}$	Per Capita Federal Education Assistance (\$000); lagged one period.
$DNSITY_{j,t-1}$	Population density (population/acres); lagged one period.
$PSRVC_{j,t-1}$	Percent services industry employment (service SIC employment/employment for private, non-farm SICs); lagged one period.
$POPE_{j,t-1}$	Percent other private industry employment (employment for private, non-farm industry SICs excluding services and manufacturing/employment for private, non-farm SICs); lagged one period.
$CS_{j,t-1}$	Coefficient of Industry Specialization, lagged one period: $\left(\frac{1}{2}\sum_{i=1}^{n}\left\lvert\frac{\mathbf{EMP}_{ij,t-1}}{\mathbf{EMP}_{j,t-1}}-\frac{\mathbf{EMP}^{\mathbf{US}}_{i,t-1}}{\mathbf{EMP}^{\mathbf{US}}_{t-1}}\right\rvert\right)$, $0 \le CS_{j,t-1} \le 1$
$FARM_{jt}$	Employment for farming SIC in year t.

Notes: 1. Measures are at the county level unless otherwise stated
2. i denotes industry i
3. j denotes county j
4. t denotes year t

conventional wisdom regarding employment multipliers, this anticipated outcome supports proposition (1); the idea that increases in base labor spur positive indirect employment effects. However, in consideration of proposition (2), which states decreases in base employment generally exert a positive indirect effect as well, the anticipated direction of $\lambda\beta_1$ really says the positive effects of defense labor increases outweigh the asymmetrical, or negative effects of defense labor decreases. Because the *Levels* model form does not permit decomposition of these countervailing effects, DEF is expected to test insignificant in one or more of the *Levels* model variations. But the *Levels* model represents only a baseline. Its conversion to a *Changes* form presents modeling solutions to this concern and the issue of instrumental variable selection for the lagged dependent variable, private employment ($EMP_{j,t-1}$). The *Changes* form is used to examine propositions (4) and (5).

Data Collection and Adjustments

The observations for this study are compiled from a variety of sources into one panel data set spanning 20 years (1978-1997) and 3,092 counties. Virtually every U.S. county for the 50 United States, plus Washington DC, is included in the set. The only regions excluded are portions of Alaska that account for 20% of its population. Numerous boundary redefinitions for these areas between 1978 and 1997 rendered related data unusable. The data set includes 61,840 records.

Employment and Income

Industry level employment and income figures (excluding military and defense civilians), as well as overall population values are from the BEA's 1969-1998 Regional Economic Information System (REIS) CD ROM disk. REIS employment figures estimates are largely by place of work. Income figures are place of residence and adjusted via the GDP deflator to 1998 dollars.

Military and Defense Civilian Personnel

The REIS database cannot be used to obtain the necessary defense personnel figures for a number of reasons. First, defense civilians are not reported as such; they are rolled up into the overall federal civilian category. Second, the REIS military figures reflect both full-time active duty members, and part-time guard and reserve personnel. Because guard and reserve personnel generally work in that capacity only one weekend per month, and two weeks per year, place of work and place of residence often do not coincide for these members. As such, that portion of the military employment figure reflects aggregate data apportioned to the county level based on population. This creates a significant complication in the data since the guard and reserve represent 39 percent of the uniformed service members (1999 figures). Finally, examination of base reutilization impacts requires installation level figures so defense personnel in a given county can be identified to either ongoing operations, or discontinued operations, whichever the case may be. As it is, a number of counties host both types of installations. Since the lowest level of

aggregation for REIS data is county level, it is not possible to make this distinction using those figures. Consequently, military and defense civilian personnel figures for 1977-1999 are from the *DoD Distribution of Personnel by State and by Selected Locations* published annually by the Directorate for Information Operations and Reports, Washington Headquarters Services, Office of the Secretary of Defense.

The *DoD Distribution of Personnel* figures are reported at the installation level, or by city in cases where personnel are stationed at a unit geographically separated from a base (e.g., ROTC staffs, Defense Plant Representative Offices, recruiters, etc). After making adjustments for known name changes, the number of stateside locations hosting defense personnel at any point over the 23 years sampled total 963. The majority of these figures were compiled manually as they were not available in electronic form. Column-footing and cross-footing were used to ensure accuracy of data transcription. Though data for additional years is available, manual transfer was deemed too time intensive given the reporting convention used prior to 1977. In either case, the selected interval allows for 10 years of data prior to the first BRAC, and 10 years subsequent to that round.

The military and defense civilian personnel figures are reported as of fiscal year end (September 30, 19XX). However, REIS figures are essentially weighted average levels across the calendar year. Therefore, the DoD figures are adjusted to coincide with the REIS data. Specifically, calendar year weighted averages were derived using the following formula: CYWAX2 = (9/32) x 30SEPX1 + (22/32) x 30SEPX2 + (1/32) x 30SEPX3, where CYWAX2 is

calendar year weighted average employment for year X2, and 30SEPXX is the reported defense employment level as of September 30^{th} 19XX.[29] This results in the loss of two years of military personnel data: 1977 and 1999. The latter year is not a "real" loss since corresponding REIS data only covers employment, income, and military retiree data through 1997.

The use of detailed installation personnel data for all stateside military sites addresses three limitations of earlier BRAC impact studies: (1) it facilitates a comprehensive review covering all 50 states; (2) it factors in defense personnel dynamics of non-BRAC sites which share a county with a BRAC installation; and (3) it explicitly considers the time dimension for personnel flows out of the base, rather than assuming draw downs occurred en masse. Addressing the first limitation helps to paint a whole picture and ensure robust results. However, addressing the latter two limitations is of greatest concern. Failure to consider net growth (net losses) for non-BRAC sites within BRAC counties will bias the multiplier estimates downward (upward). The potential for such bias is great given the 88 counties that were home to 97 major BRAC sites, were also home

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[29] This approach assumes personnel increases/decreases occur on a straight-line basis from one measurement date to the next. Specifically, from SEPX1 to SEPX2, the average monthly change is (SEPX2-SEPX1)/12. Similarly, from SEPX2 to SEPX3 the average monthly change is (SEPX3-SEPX2)/12. On a straight-line basis, the level at JANX2 is then SEPX1 + 3[(SEPX2-SEPX1)/12], or SEPX1 + (3/12)(SEPX2-SEPX1). For JANX3 it is SEPX2 + (3/12)(SEPX3-SEPX2). From JANX2 to SEPX2 the monthly change is constant at (SEPX2-SEPX1)/12, and from SEPX2 to JANX3 it is constant at (SEPX3-SEPX2)/12. Therefore, the weighted average personnel levels for calendar year 19X2 can be arrived at through the following formula: (9/12)[(JANX2 + SEPX2)/2] + (3/12)[(SEPX2 + JANX3)/2] = (9/24)(JANX2 + SEPX2) + (3/24)(SEPX2 + JANX3). Substitution for JANX2 and JANX3 yields (9/24)[SEPX1 + (3/12)(SEPX2-SEPX1) + SEPX2] + (3/24)[SEPX2 + SEPX2 + 3/12(SEPX3-SEPX2)] = (9/24)(9/12SEPX1 +(15/12)SEPX2) + (3/24)[(21/12)SEPX2 + (3/12)SEPX3) = (81/288)SEPX1 + (135/288)SEPX2 + (63/288)SEPX2 + (9/288)SEPX3 = ***(9/32)SEPX1 + (22/32)SEPX2 + (1/32)SEPX3***.

to 195 other military facilities, which continued operations. The time dimension of personnel flows is important because under BRAC guidelines, the services are given up to six years to close a base. As such, the actual closure execution interval can vary from base to base. In fact, for BRAC '88 and BRAC '91, closure intervals averaged just under 5- ½ years , and just over 3 years, respectively (GAO, 1998).[30] If personnel reductions are assumed to occur en masse on the official closure date when in fact they were evenly spread or loaded toward the front of the 6-year window (as is likely the case since the delays on most closures related to cleanup and reutilization preparation, rather than personnel adjustments), multiplier estimates may very well be biased downward.

To give an idea of the magnitude and scope of stateside defense presence, the geographic distribution of defense personnel in 1977 (the beginning of the data collection period) is presented in Figure 6. The areas experiencing the greatest losses of defense personnel across the subsequent 20 years are illustrated in Figure 7.

Base Realignment and Closure Classification

Sources for BRAC data (i.e., bases selected for closure or reduction, and the year chosen) are the OEA webpage, the March 31, 1999 OEA Base Reutilization Status Report, and the 1996 CRS report, *Military Base Closures Since 1988: Status and Employment Changes at the Community and State*

[30] Averages for the last two BRACs ('93 and '95) were not available in GAO's 1998 report since at the time of publication six years had not yet lapsed under either closure round.

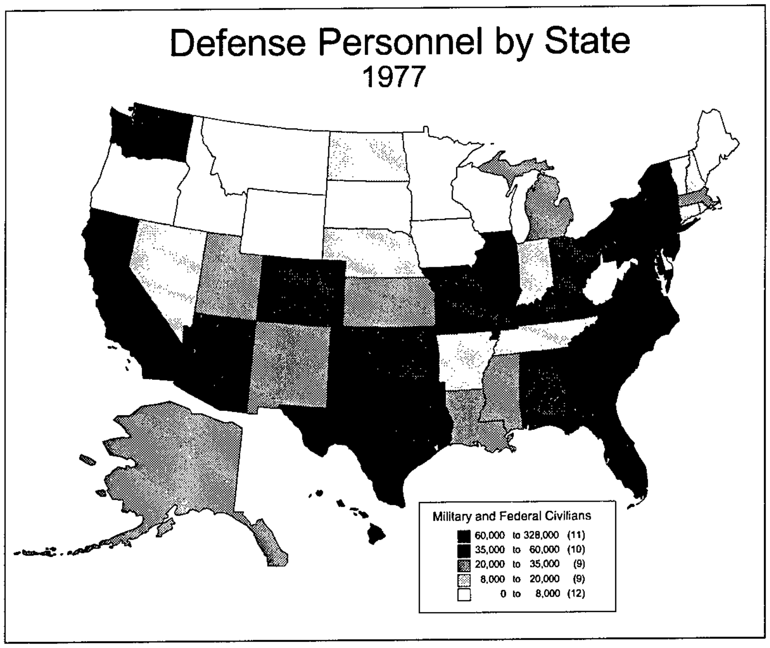

Figure 6 - Defense Personnel Distribution

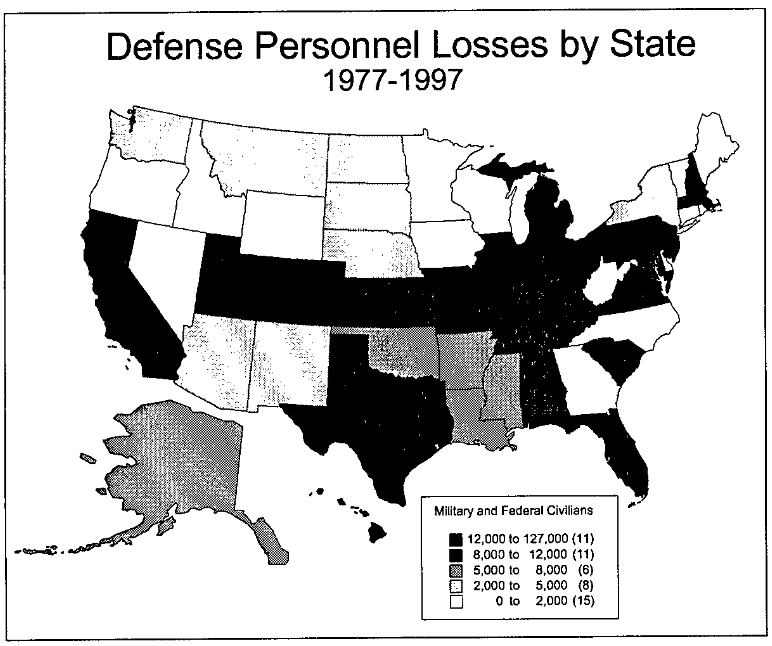

Figure 7 - Distribution of Defense Personnel Losses

Level. From this list of BRAC sites, bases are classified as major BRAC installations if the facility employed at least 300 military and defense civilians in 1987 or thereafter. This criteria closely parallels the U.S.C. Title 10 requirement for Congressional approval of restructuring actions that impact more than 1,000 *or* half the resident federal workers at bases of 300 or more employees. A total of 97 installations are identified and classified as major BRAC facilities (see Appendix C). The corresponding labor force is identified as BRAC related via a dummy variable, which takes the value of one beginning with the first post-selection year these employment levels peaked. In most cases the "peak" was the year of selection. In some instances, post-BRAC base employment levels did not "peak" until 1-3 years after the base's selection. Because these BRAC military and civilian levels represent public infrastructure capacity that may come available for private reutilization, it only makes sense to identify the workforce as such once the base begins its draw down, and thereafter. Initially, the distinction of BRAC related personnel reductions is used to apportion installation acreage reuse figures across the periods land transfers most likely occurred.[31] This distinction is also beneficial later when the defense employment change variable is decomposed into its positive and negative components.

After making the "BRAC" vs. "ongoing" distinction for defense personnel data, the figures are aggregated at the county level. A total of 499 counties played host to the 963 military facilities noted above – an average of nearly two

installations per military county. Of these 499 counties, four are dropped as part of the Alaskan areas for which consistent REIS data is not available over the sample period. Composed mostly of remote early ballistic missile warning and air defense activities, the military presence associated with these four counties is relatively minor and does not include any of the major BRAC installations.

Military Counties

The corresponding counties for each of the 962 military locations are determined primarily through CD Light's ZIPlist5™ database on the Internet.[32] In many cases the station name is too narrow for this database, so an intermediate step of obtaining applicable ZIP codes through the US Postal Service is used. In some instances, Internet search sites, mapping software, and a Rand McNally Road Atlas are employed extensively to pinpoint the exact geographical location of the installation.

Base Facilities Reutilization

Variables representing facilities reutilization under BRAC are derived from personnel flows and base acreage data. Specifically, values of cumulative land areas declared excess by base, through November 2000, are from the OEA. These figures are spread over time in proportion to personnel outflow patterns at

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[31] Detail regarding the periods in which actual land transfer transactions occurred was not available, so it was necessary to develop a rational means for apportioning cumulative figures across time.
[32] www.zipinfo.com

the respective BRAC sites. Apportionment starts with the first year following BRAC selection in which base personnel levels were at their peak. While these are not precise measures, the combination of personnel flows and excessed acreage data should be fairly representative of the actual resources made available *or anticipated to be available* for private reuse.

Oil and Energy Prices

Oil and energy price data are from the Energy Information Administration (EIA), U.S. Department of Energy. The energy figures (dollars per million BTU's) are state-level values from the source data for the 1997 EIA State Energy Price and Expenditure Report (SEPER). For consistency with income figures in the data set, these values are adjusted to 1998 dollars via the GDP deflator.

Chapter IV

FINDINGS

Random vs. Fixed Effects in the Levels Model

The analysis begins with a comparison of the *Levels* model in equation (8) in its random effects and fixed effects forms (see page 61). Recall the only adjustment required to express (8) in the period and group fixed effects form is the addition of year and county dummy vectors, Λ_t and Ψ_j, and replacement of $u_t + v_j + w_{jt}$ with the completely random error term, e_{jt}. The relevant results are summarized in Table 3 and Table 4.

Keeping with Kmenta (1997), the LaGrange multiplier statistic is used to test if the random effects model is more appropriate than the OLS form. Specifically, the hypothesis is:

$$H_0: \sigma_u^2 = \sigma_v^2 = 0$$

$$H_A: H_0 \text{ is not true}$$

Table 3 – *Levels* Model Results, OLS and Random Effects

Dependent Variable: EMP_{jt}

	OLS		Random Effects (j & t)	
	Coeff	T-Stat	Coeff	T-Stat
DEF_{jt}	0.10	25.00 **	0.12	17.10 **
$LAND_{jt}$	0.79	11.29 **	0.64	9.09 **
$STNRGY_{j,t-1}$	8.62	1.04	62.19	3.52 **
$PPI_{j,t-1}$	33.96	2.41 *	4.01	0.20
SLG_{jt}	-0.02	-6.16 **	0.00	0.16
$PCIMBP_{j,t-1}$	-1.15	-11.82 **	-0.93	-5.98 **
$PWR_{j,t-1}$	32.40	8.63 **	12.30	2.02 *
$PCFEA_{j,t-1}$	-0.09	-0.21	1.31	1.98 *
$DNSITY_{j,t-1}$	-0.20	-23.37 **	-0.18	-12.06 **
$PSRVC_{j,t-1}$	1734.76	8.20 **	1177.77	3.67 **
$POPE_{j,t-1}$	466.03	3.16 **	552.49	2.48 *
$CS_{j,t-1}$	-1201.71	-6.59 **	-1279.87	-4.49 **
$FARM_{jt}$	0.27	20.65 **	0.29	13.46 **
$EMP_{j,t-1}$	1.02	2816.78 **	1.01	1723.69 **
	R^2 =	0.999	R^2 = †	
	F-Stat =	5,703,579		
	$F_{(0.05,\ 14,\ 58733)}$ =	1.70		

(counties, n = 3092; years, T = 19)

† GLS estimation used in the random effects model does not produce a precise counterpart to R^2.

* Significant at the 95 percent level.

** Significant at the 99 percent level.

Table 4 – *Levels* Model Results, Fixed Effects

Dependent Variable: EMP_{jt}

	Region Fixed Effects (j)		Period Fixed Effects (t)		2-Way Fixed Effects (j & t)	
	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Ψ_j	not shown		NA		not shown	
Λ_t	NA		not shown		not shown	
DEF_{jt}	-0.07	-2.08 *	0.10	25.18 **	-0.06	-1.90
$LAND_{jt}$	0.94	11.97 **	0.76	10.99 **	0.91	11.64 **
$STNRGY_{j,t-1}$	-82.79	-7.34 **	94.14	7.64 **	4.65	0.14
$PPI_{j,t-1}$	147.28	4.40 **	33.36	2.38 *	76.51	2.23 *
SLG_{jt}	-0.11	-7.54 **	-0.02	-6.35 **	-0.10	-6.97 **
$PCIMBP_{j,t-1}$	-0.50	-2.05 *	-1.28	-12.69 **	-0.52	-1.77
$PWR_{j,t-1}$	73.21	11.27 **	25.22	5.62 **	86.47	8.99 **
$PCFEA_{j,t-1}$	3.24	2.92 **	0.41	0.93	5.98	5.36 **
$DNSITY_{j,t-1}$	0.69	2.74 **	-0.20	-23.55 **	0.57	2.29 *
$PSRVC_{j,t-1}$	2291.29	4.19 **	1351.41	6.11 **	2104.44	3.70 **
$POPE_{j,t-1}$	1032.67	2.43 *	629.95	4.25 **	649.26	1.54
$CS_{j,t-1}$	-623.61	-1.05	-1143.25	-6.29 **	-779.59	-1.31
$FARM_{jt}$	0.22	3.04 **	0.26	20.41 **	0.09	1.29
$EMP_{j,t-1}$	0.97	654.65 **	1.02	2840.64 **	0.97	658.04 **
	$R^2 =$	0.999	$R^2 =$	0.999	$R^2 =$	0.999
	F-Stat =	30,615	F-Stat =	2,539,500	F-Stat =	31,001
	$F_{(0.05, 3105, 55642)} =$	1.30	$F_{(0.05, 32, 58715)} =$	1.45	$F_{(0.05, 3124, 55623)} =$	1.30

(counties, n = 3092; years, T = 19)

* Significant at the 95 percent level.
** Significant at the 99 percent level.

The test yields a statistic that far exceeds the critical value of χ^2, so the resulting conclusion is to accept the alternative hypothesis, H_A.[33] Therefore, the classical OLS model is not the appropriate choice for the data.

Next, the Hausman test is used to evaluate the three error component (2-way) random effects form against the combined period and group fixed effects model in Table 4. The test statistic, **W**, is based on the Wald criterion.[34] Once again, the computed value far exceeds the critical value of χ^2.[35] It follows that the additional period and group error components of the random effects model are not orthogonal. As a result, estimates under the random effects specification will not be consistent, so the fixed effect model becomes the appropriate choice of the two.

The Hausman test is also performed on both 1-way random effects model variations (i.e., period-only and region-only). In both cases, the same outcome is realized: the fixed effects forms are superior.[36] This comes as no surprise – particularly with respect to the region fixed effects model since the analysis is comprehensive rather than a random sampling of U.S. counties. Both Greene (2000) and Kmenta (1997) hint at this eventuality. With those two references and

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[33] For the random effects model in Table 3, **LM** = 31,495. The 99.5 percent critical value of χ^2 with two degrees of freedom, χ_2^2 = 10.66.

[34] Reference Greene (2000).

[35] For the 2-way random effects and fixed effects models, the value of **W** = 2,809. With 14 degrees of freedom, the 99.5 percent critical value of χ^2 is 31.

[36] The W-statistic has a value of 2,875 for the region random effects vs. region fixed effects models, and a value of 40 for the period random effects vs. period fixed effects models. At the 99.5% level, the critical value of χ_{14}^2 = 31.

the test results above in mind, random effects (error components) specification forms are excluded from further consideration in this study.

It is worth noting the choice of fixed effects models can be examined in another light. Specifically, as demonstrated by Greene (2000), F statistics can be used to test the joint significance of period fixed effects and region fixed effects.[37] In the case of period fixed effects, the F test results point to this model form over OLS.[38] Further testing yields results that support the region fixed effects model over simple OLS.[39] Finally, in the presence of region fixed effects, the F test results suggest the combined period and region fixed effects model is the better choice.[40] This choice comes at a considerable loss in terms of degrees of freedom (i.e., one region dummy variable for each of 3,092 counties), but the sheer size of the data set more than accommodates.

A few additional observations can be made from results in Table 3 and Table 4. First, the large F-statistics suggest the models as a whole are significant. The explanatory power of all five models is also very high ($R^2 > 0.99$). Of course, this is to be expected with a lagged dependent variable on the

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[37] For period fixed effects vs. OLS, the statistic is: $[(R^2_u - R^2_r)/(n-1)]/[(1-R^2_u)/(nT - n - K)]$. The region fixed effects vs. OLS, the statistic is: $[(R^2_u - R^2_r)/(T-1)]/[(1-R^2_u)/(nT - T - K)]$. For two-way vs. region-only fixed effects, the statistic is $[(R^2_u - R^2_r)/(T-1)]/\{(1-R^2_u)/[(n-1)(T-1) - K)]\}$.
[38] From Table 3, R^2 for the OLS form, $R^2_r = 0.99927$. R^2 for the unrestricted period fixed effects model, R^2_u, is 0.99928 (reference the second model in Table 4). For the period-only fixed effects model, F-Stat = 58.90, and at the 95 percent level, $F_{(18,\ 58714)} \approx 1.61$. This outcome favors the period effects model over simple OLS.
[39] From Table 3, R^2 for the OLS form, $R^2_r = 0.99927$. R^2 for the unrestricted region fixed effects model, R^2_u, is 0.99942 (reference the first model in Table 4). For the region-only fixed effects model, F-Stat = 4.62. The critical value of F at the 95 percent level is $F_{(3091,\ 55,641)} \approx 1.30$. This result supports a region fixed effects model over simple OLS.
[40] In this case, the restricted model is the region-only fixed effects one, while the unrestricted model is the region and period fixed effects form. $R^2_r = 0.99942$ and $R^2_u = 0.99943$. The result is

(continued on next page)

right-hand side. Focusing only on the 2-way fixed effects model, all of the control variables except state and local government employment (SLG_{jt}), and lagged state-level energy cost ($STNRGY_{j,\,t\text{-}1}$) have the expected signs. However, the latter, along with $PCIMBP_{j,t\text{-}1}$,$P\ OPE_{j,t\text{-}1}$,$CS_{\ j,t\text{-}1}$, $FARM_{jt}$ are not significant. For the remaining four models, all but one or two of the variables are significant and most of the signs are as expected. It should also be noted that where applicable, the period and region dummy variables in these fixed effects models and all the ones that follow generally are significant, though the coefficients and T-statistics are not reported to save space.

Between the five models of Table 3 and Table 4, SLG_{jt} and $STNRGYj_{,t\text{-}1}$ are least consistent with expectations. In-depth comments about this outcome are deferred because these results represent only a rudimentary first look at modeling form. Suffice it to say the addition of *Change* variables that cannot be literally adapted from the *Levels* form, along with the results of the forthcoming *Changes* models, suggest these estimates probably suffer from modeling form error and omitted variable bias.

All of the *Levels* model specifications imply the relationship between defense employment and local private employment must be either positive or negative; none of them allow examination of both possibilities (i.e., asymmetrical relationships). That said, of the two defense employment impact propositions, only the first (Proposition 1) can be examined. The OLS, random effects, and

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that F-Stat = 59.22. At the 95 percent level, $F_{(18,\,55623)} \approx 1.61$, so the two-way fixed effects model *(continued on next page)*

period-only fixed effects results support Proposition (1) since the signs of the defense employment variable, DEF_{jt}, are positive and significant in these three models. Assuming asymmetrical employment effects exist, the net positive signs of the defense variables in these *Levels* models imply the positive effect of base employment increases overwhelm the inverse relationship of base employment decreases. If one expects the effect of job creation through build up to be more pronounced than that of job creation through destruction, this stands to reason. However, the overall negative (and significant) DEF_{jt} coefficient in the region-only fixed effects model suggests just the opposite. Clearly, the decomposition of positive and negative defense personnel movements under the *Changes* model will shed light in this area.

Finally, the signs and significance of the installation reutilization proxy, $LAND_{jt}$, lend support for Proposition (3). Specifically, in the two models on Table 3 and the three on Table 4, the coefficients for $LAND_{jt}$ suggest that as base land and infrastructure is released to the community, local employment increases by a factor of between 0.64 and 0.94 jobs per acre.

None of the *Levels* models address concerns over the lagged dependent variable's independence with respect to the error term. This oversight is by design because the next step in the process is to examine the *Changes* model, which offers a solution to this issue. Furthermore, by its very nature of first differencing, the *Changes* model eliminates concerns with region related random

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is superior.

or fixed effects, as the corresponding random error components or fixed dummy variables cancel out. With respect to the 2-way fixed effects *Levels* model, this translates to the recovery of the large loss in degrees of freedom discussed earlier. If an interim conclusion can be made, it's that the random effects model forms can be abandoned in the remaining analysis based on the desire to capture macroeconomic influences via period dummy control variables and the test results thus far. This decision is congruent with a priori reasoning regarding the sample type. Specifically, Greene (2000) suggests the region fixed effects form is reasonable where 100% population sampling of the cross-sectional data is involved and differences between the regions "... can be viewed as parametric shifts of the regression function." Baltagi (1995) reinforces this notion, noting the fixed effects form is appropriate when inferences about the results are not intended to extend beyond the sample. For all practical purposes, this study and the data fulfill these criteria.

Literal Transformation of the Levels Model to a Changes Form

Notwithstanding the results of the *Levels* models above, the desire to decompose defense employment impacts into their positive and negative elements points to the *Changes* variation of the model in equation (8) as the stronger contender. The first difference specification form also helps in addressing concerns with instrumental variable selection for the lagged dependent variable.

First differencing simply involves subtracting the previous period's value for a given variable, from the current period's value. For example, the dependent variable in the *Changes* model is defined as:

$$EMPCHG_{jt} = EMP_{jt} - EMP_{j,t-1} \tag{9}$$

Equation (10) reflects the literal *Changes* form for the 2-way fixed effects *Levels* version of the model in equation (8). Definitions for the right-hand side variables in (10) are provided in Table 5.

$$\begin{array}{lll}
EMPCHG_{jt} & = \Lambda_t - \Lambda_{t-1} & \\
 & + \Psi_j - \Psi_j \ (= 0) & \\
 & + \lambda\beta_1 DEFCHG_{jt} & \lambda\beta_1 \quad > 0 \\
 & + \lambda\beta_2 LANDCHG_{jt} & \lambda\beta_2 \quad > 0 \\
 & + \lambda\gamma_1 STNRGYCH_{j,t-1} & \lambda\gamma_1 \quad < 0 \\
 & + \lambda\gamma_2 PPICHG_{j,t-1} & \lambda\gamma_2 \quad > 0 \\
 & + \lambda\gamma_3 SLGCHG_{jt} & \lambda\gamma_3 \quad > 0 \\
 & + \lambda\gamma_4 PCIMBPCH_{j,t-1} & \lambda\gamma_4 \quad < 0 \\
 & + \lambda\gamma_5 PWRCHG_{j,t-1} & \lambda\gamma_5 \quad > 0 \\
 & + \lambda\gamma_6 PCFEACHG_{j,t-1} & \lambda\gamma_6 \quad > 0 \\
 & + \lambda\gamma_7 DNSITYCH_{j,t-1} & \lambda\gamma_7 \quad > 0 \\
 & + \lambda\gamma_8 PSRVCCHG_{j,t-1} & \lambda\gamma_8 \quad > 0 \\
 & + \lambda\gamma_9 POPECHG_{j,t-1} & \lambda\gamma_9 \quad > 0 \\
 & + \lambda\gamma_{10} CSCHG_{j,t-1} & \lambda\gamma_{10} \quad < 0 \\
 & + \lambda\gamma_{11} FARMCHG_{jt} & \lambda\gamma_{11} \quad > 0 \\
 & + (1-\lambda) EMPCHG_{j,t-1} & (1-\lambda) > 0 \\
 & + e_{jt} &
\end{array} \tag{10}$$

With regard to the period dummy variables, the *Changes* model above presents some difficulties. Specifically, first differencing these dummies yields

Table 5 – Initial *Changes* Model Variables

Variable	Definition
$DEFCHG_{jt}$	Change in military and defense federal civilian employment, from year t-1 to year t.
$LANDCHG_{jt}$	Proxy for BRAC facilities converted to reuse (acres) in year t. This figure is based on the actual area of land declared excess for non-defense reutilization, spread over time in proportion to the draw down of personnel at the respective BRAC sites.
$STNRGYCH_{j,t-1}$	State level change in the composite cost of energy, from t-2 to t-1.
$PPICHG_{j,t-1}$	Change in Population Pressure Index, from t-2 to t-1.
$SLGCHG_{jt}$	State and Local Government employment, from t-1 to t.
$PCIMBPCH_{j,t-1}$	Change in Per Capita Income Maintenance Benefit Payments, from t-2 to t-1.
$PWRCHG_{j,t-1}$	Change in Private Wage Rate, from t-2 to t-1.
$PCFEACHG_{j,t-1}$	Change in Per Capita Federal Education Assistance, from t-2 to t-1.
$DNSITYCH_{j,t-1}$	Change in population density, from t-2 to t-1.
$PSRVCCHG_{j,t-1}$	Change in percent service industry employment, from t-2 to t-1.
$POPECHG_{j,t-1}$	Change in percent other private industry employment, from t-2 to t-1.
$CSCHG_{j,t-1}$	Change in the Coefficient of Industry Specialization; interaction variable for use with defense variables in the *Changes* model (see Table 2 for Coefficient of Industry Specialization computation).
$FARMCHG_{jt}$	Change in farming employment, from t-1 to t.
$EMPCHG_{j,t-1}$	Lagged dependent variable (i.e., change in non-farm private employment, from t-2 to t-1).

Notes: 1. Measures are at the county level unless otherwise stated
2. i denotes industry i
3. j denotes county j
4. t denotes year t

values of 1 if $\Lambda_t = 1$ ($\Lambda_t - \Lambda_{t-1} = 1 - 0 = 1$), but it also yields values of -1 when $\Lambda_{t-1} = 1$ ($\Lambda_t - \Lambda_{t-1} = 0 - 1 = -1$). Intuitively, this literal transformation has no meaningful economic interpretation. However, recognizing the intent is to control for macroeconomic influences in a given year, or changes in these factors from one year to the next, use of period dummies (Λ_t) in the *Changes* model, rather than differences in these dummies ($\Lambda_t - \Lambda_{t-1}$) more appropriately addresses concerns with national level control variables. The first attempt at a *Changes* form of the *Levels* model is adjusted accordingly. This adjustment is the only deviation from the literal transformation of the *Levels* models already considered. The coefficient estimates for the transformed models are presented in Table 6.

Results for the classical form appear first. The period-only fixed effects model is again evaluated against the OLS model through the F test. As with the *Levels* period-only fixed effects model, the F statistic exceeds the critical value, so the period fixed effects form of the *Changes* model is superior to simple OLS.[41] Region-only and two-way (period and region) fixed effects models are excluded from the literal *Changes* analysis. As discussed earlier and noted in equation (10), this is because under first differencing, time invariant region fixed effects, Ψ_j, drop out.

When running the models in Table 6, the routine statistical output provides a Durbin-Watson value of 1.877, which, being close to 2, hints at rejecting the possibility of autocorrelation. But, as Gujarati (1995) notes, in autoregressive

Table 6 – Literal Transformation of *Levels* Model to *Changes* Form

Dependent Variable: $EMPCHG_{jt}$

	OLS		Period Fixed Effects (t)		Period Fixed Effects (t) (Autocorr. Corrected)	
	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Λ_t	NA		not shown		not shown	
$DEFCHG_{jt}$	-0.22	-4.19 **	-0.21	-4.07 **	-0.21	-4.03 **
$LANDCHG_{jt}$	2.37	11.83 **	2.31	11.64 **	2.30	11.18 **
$STNRGYCH_{j,t-1}$	-242.12	-15.96 **	-91.57	-2.24 *	-75.75	-1.86
$PPICHG_{j,t-1}$	429.28	8.39 **	346.72	6.75 **	368.42	7.16 **
$SLGCHG_{jt}$	1.06	34.36 **	1.08	35.25 **	1.16	37.32 **
$PCIMBPCH_{j,t-1}$	1.23	2.58 *	-0.67	-1.22	-0.67	-1.21
$PWRCHG_{j,t-1}$	151.35	9.40 **	173.49	10.33 **	174.34	10.39 **
$PCFEACHG_{j,t-1}$	3.78	3.06 **	3.63	2.88 **	3.58	2.90 **
$DNSITYCH_{j,t-1}$	9513.47	15.80 **	9030.98	15.13 **	9382.48	15.19 **
$PSRVCCHG_{j,t-1}$	2693.29	3.51 **	1424.76	1.85	1414.40	1.85
$POPECHG_{j,t-1}$	1911.04	3.24 **	1758.00	2.99 **	1821.14	3.12 **
$CSCHG_{j,t-1}$	-3665.65	-4.25 **	-4749.17	-5.53 **	-4934.25	-5.78 **
$FARMCHG_{jt}$	1.13	10.60 **	1.13	10.34 **	1.13	10.39 **
$EMPCHG_{j,t-1}$	639.75	203.87 **	641.37	205.48 **	612.99	191.04 **
Final est. of Rho	NA		NA		0.08	20.64 **
	R^2 =	0.531	R^2 =	0.540	R^2 = †	
	F-Stat =	4,743	F-Stat =	2,153	F-Stat = †	
	$F_{(0.05, 14, 58733)}$ =	1.70	$F_{(0.05, 32, 58715)}$ =	1.45	$F_{(0.05, 32, 58715)}$ = †	

(counties, n = 3092; years, T = 19)

† Results are based on transformed data (i.e., $y^*_{j1} = (1 - \rho^2)^{1/2} y_{j1}$; $y^*_{jt} - \rho y_{j,t-1}$, for t = 2 to T; and similarly for x^*_{jt}), so these statistics are not meaningful.

* Significant at the 95 percent level.

** Significant at the 99 percent level.

[41] In this case, $R^2_u = 0.54$; $R^2_r = 0.53$; n = 3,092; T= 19; K = 15. The computed F statistic, F-Stat = 66.09. At the 95 percent level, $F_{(18, 58714)} \approx 1.61$.

models like this partial adjustment one, there is an integral bias toward overlooking serial correlation in the D-W statistic. Durbin's **M** test is suggested as an alternative.[42] Test results indicate the null hypothesis of zero autocorrelation cannot be rejected.[43] However, as suggested in Kmenta (1997), wrongly assuming the disturbances are independent is much more damaging than allowing for autoregression that may not be present. In that light, the third model in Table 6, and all remaining models in this study are corrected for first order autocorrelation via the Prais-Winsten iterative method. Under this transformation technique, as outlined in Kmenta (1997), none of the observations are lost. The first estimate of ρ, $\hat{\rho}$ is approximated from the D-W statistic, d, such that $\hat{\rho} \cong 1 - \frac{1}{2}d$, in accordance with Greene.[44] Only one iteration is required and the final estimate of rho, $\hat{\rho} = 0.085$.

For all the control variables in the two period fixed effects models of Table 6, the signs of the coefficients are exactly as expected. Contrasting the 2-way fixed effects *Levels* model with the AR(1) corrected, period-fixed effects *Changes* model, the transformation seems to have righted the signs for the effects of state and local government programs ($SLGCHG_{jt}$) and state-level energy costs ($STNRGYCH_{j,t-1}$). The latter continues to be insignificant, as does the income

[42] The procedure, as adapted from Gujarati (1995) involves a two step process: (1) Obtain the estimated error terms, $\hat{\mu}_t$ from an OLS regression of the original model; (2) Regress the $\hat{\mu}_t$ on the original regressors, plus the lagged value of the estimated error term, $\hat{\mu}_{t-1}$. The resulting value of R^2 is then multiplied by $(n - p)$ to produce the **M** statistic, which approximates χ_p^2 (p is used to denote the level of serial correlation; e.g., p = 1 reflects a 1st order autoregressive scheme).
[43] $\mathbf{M} = (n - p) \times R^2 = (19\text{-}1) \times 0.015 = 0.26$. At the 95% level, the critical value of χ_I^2 is 3.84. Since $\chi_I^2 > \mathbf{M}$, $H_0{:}\rho = 0$ cannot be rejected.

maintenance benefit payments variable ($PCIMBPCH_{j,t-1}$). The percent other private employment ($POPECHG_{j,t-1}$), coefficient of specialization ($CSCHG_{j,t-1}$), and farm employment ($FARMCHG_{jt}$) change variables all become significant in the *Changes* model. In fact, regarding expectations, the only adverse change between the two models is the *percent services employment* variable loses its significance in the period-fixed effects, *Changes* AR(1) model.

Looking at the primary variables of interest, the defense installation reutilization proxy ($LANDCHG_{jt}$) is positive and highly significant, lending support to Proposition (3). Interestingly $DEFCHG_{jt}$, though significant, is opposite in sign from what most would expect. The negative coefficient seems to suggest that increases in defense employment lead to decreases in local private employment. This is likely due to specification error that can be resolved through the decomposition of defense personnel changes into negative and positive elements. Decomposition is explored following the discussions on defense county dummy variables, and lagged dependent variable instruments.

Defense County Dummy Variables

Since the time Spanish explorers and English settlers colonized America, to the early 1900s, the need to protect vital ports and trade routes drove domestic military location and fortification strategies. But involvement in two world wars and changes in technology – most notably, the ability to project power

[44] Reference Greene (2000), equation (13-26), page 538, and related discussion on page 546.

quickly and en masse – altered this causal relationship. By the mid-1950s, military installation location drove transportation infrastructure development. In fact, a major justification for the Federal Aid-Highway Act of 1956, which initiated construction of 41,000 miles of interstate highways, was the support of rapid and large-scale troop mobilization (Cox, 1996). Combined with the boom in automobile ownership, this nodal transportation network made America the mobile society it is today. Not surprisingly, economic studies give recognition to the link between public highway spending and regional employment growth (e.g., Dalenberg, et.al., 1998; Fox and Murray, 1991).

In either of the above instances – bases following trade routes, or highways and railways accommodating bases – it is fair to assume military installations are indicators of regions characterized by greater than average growth potential. The effect of this growth rate differential can be captured through an installation age variable in the *Levels* model. Intuitively, the expectation is that the longer an installation is in place, the higher the expected level of employment attributable to the accompanying transportation network. However, the data set at hand does not include installation age information. Fortunately, the *Changes* model presents an opportunity to bypass this shortcoming. Recognizing the *Changes* model simply involves first differencing, the resulting installation age differences will always take a value of one, even if the actual age is unknown. In other words, under the *Changes* model, dummy variables used to identify counties with a defense presence are the literal equivalent of installation age variables in the *Levels* model.

Defense county dummy variables serve another purpose as well: they capture the effect of military retiree location trends. Specifically, there is a propensity for military retirees to establish residence near DoD bases. In essence, the variety of benefits available through military installations (e.g., medical, legal, chaplain services, tax-free retail shopping, etc.) plus the fertile market for military skills and experience exacts a "magnetic pull" on retiring members when they select their next community of residence. Dardia's 1995 study of BRAC impacts in California, and the 1998 GAO review of prior BRAC rounds give recognition to this phenomenon. This location trend translates to additional induced employment effects for counties with a defense presence. Accordingly, the literal *Changes* model is appended to include defense county dummies ($DEFDV_j$) as proxies for developed transportation infrastructure and the "retiree effect." The results are presented in Table 7.

Inclusion of defense county dummy variables has no effect on the signs or significance of the parameter estimates, with the exception of lagged change in state energy cost ($STNRGYCH_{j,t-1}$), which becomes significant in this model variation. The defense personnel change variable ($DEFCHG_{jt}$) is highly significant and its magnitude decreases by 24 percent, but it is still negative. As expected, the defense county dummy variable ($DEFDV_j$) is positive, and highly significant. Disregarding lagged dependent variable and defense decomposition issues, the estimated value for $DEFDV_j$ suggests 751 jobs per year are attributable to relatively better developed highway, rail, air, and sea

Table 7 – *Changes* Model with Defense County Dummy Variable

Dependent Variable: $\mathbf{EMPCHG_{jt}}$

	Period Fixed Effects (t) Corrected for Autocorrelation	
	Coeff	T-Stat
Λ_t	not shown	
$DEFCHG_{jt}$	-0.16	-3.09 **
$\mathbf{DEFDV_i}$	750.89	20.82 **
$LANDCHG_{jt}$	2.10	10.22 **
$STNRGYCH_{j,t-1}$	-85.19	-2.10 *
$PPICHG_{j,t-1}$	355.09	6.93 **
$SLGCHG_{jt}$	1.11	35.71 **
$PCIMBPCH_{j,t-1}$	-0.61	-1.11
$PWRCHG_{j,t-1}$	145.66	8.68 **
$PCFEACHG_{j,t-1}$	3.23	2.62 **
$DNSITYCH_{i,t-1}$	9340.41	15.14 **
$PSRVCCHG_{i,t-1}$	909.40	1.19
$POPECHG_{j,t-1}$	1604.57	2.76 **
$CSCHG_{j,t-1}$	-4581.18	-5.38 **
$FARMCHG_{jt}$	1.14	10.48 **
$EMPCHG_{i,t-1}$	0.60	184.39 **
Final est. of Rho	0.09	22.14 **

(counties, n = 3092; periods, T = 19)

* Significant at the 95 percent level.

** Significant at the 99 percent level.

Note: Model corrected for first order autocorrelation.

transportation networks, along with induced effects of retiree convergence, in defense counties.

Instruments for the Lagged Dependent Variable

Suppose for a moment the disturbance term is not completely random, but rather takes the form $\varepsilon_{jt} = u_t + v_j + w_{jt}$, or $\varepsilon_{jt} = v_j + w_{jt}$. As noted at the outset, complications arise in the presence of a lagged dependent variable. Specifically, in either case, under the *Levels* model, EMP_{jt} is a function of v_j and $EMP_{j,t-1}$. But this means $EMP_{j,t-1}$ is also a function of v_j. This violation of the least squares assumption that right side variables are independent of the error term results in biased estimates. First differencing under the *Changes* model appears to alleviate this concern as v_j drops out (i.e., $v_j - v_j = 0$). This is exactly the first step in remedies suggested by Baltagi (1995) and others. As it is, this step has already been taken, even though preliminary test results point toward the fixed effects specifications over the random effects ones, suggesting the disturbance term does not contain either period or region components. But concerns with the lagged dependent variable do not end here.

While much of the literature is concerned with lagged dependent variable problems in the random effects models only, Greene (2000), and Arellano and Honoré (1999) note difficulties may exist in the fixed effects form as well. Specifically, $EMP_{j,t-1}$ is correlated with Ψ_j by design in the *Levels* region (or region and period) fixed effects model. Additionally, $EMP_{j,t-1}$ is correlated with ε_{jt}, even

under the assumption that ε_{jt} is not serially correlated. First differencing to the *Changes* form removes the heterogeneity, but as seen in equation (11), a correlation problem between the lagged dependent variable and the disturbance still exists.

$$\mathrm{EMPCHG}_{jt} =$$

$$\mathrm{EMP}_{jt} - \mathrm{EMP}_{j,t-1} = \boldsymbol{\beta}'(\mathbf{X}_{jt} - \mathbf{X}_{j,t-1}) + \boldsymbol{\gamma}'(\mathrm{EMP}_{j,t-1} - \mathrm{EMP}_{j,t-2}) + (\varepsilon_{jt} - \varepsilon_{j,t-1}) \qquad (11)$$

The recommended solution is to employ an instrumental variable for $\mathrm{EMPCHG}_{j,t-1}$. Baltagi (1995) and Greene (2000) identify $\mathrm{EMPCHG}_{j,t-2}$ (= $\mathrm{EMP}_{j,t-2}$ - $\mathrm{EMP}_{j,t-3}$), and $\mathrm{EMP}_{j,t-2}$ as two viable contenders. As Kennedy (1997) and Kmenta (1997) caution, these instruments are not simply substituted for $\mathrm{EMPCHG}_{j,t-1}$, or they would function merely as proxies, yielding inconsistent estimates. Instead, they are applied in the first step of the two-stage least squares (2SLS) routine, as described in Markus (1979). The resulting fitted values are then substituted for $\mathrm{EMPCHG}_{j,t-1}$ in the second step, producing coefficient estimates that are consistent and unbiased. As Kennedy (1997) and Greene (2000) note, under instrumental variable estimation techniques, the variance-covariance matrix is larger than under simple OLS, so estimates may not be efficient. But, Kmenta (1997) shows the degree of instrumental variable driven variance is inversely related to the correlation between the lagged dependent variable and the chosen instrument. Under the circumstances, this compromise is deemed acceptable.

The model in equation (10) is appended using first $EMPCHG_{j,t-2}$, then $EMP_{j,t-2}$ as instrumental variables for $EMPCHG_{j,t-1}$. The results are reported in Table 8.

Clearly, there is an appreciable difference in outcomes between the two instrumental variable choices. Specifically, in the second model of Table 8 (where $EMP_{j,t-2}$ is the instrument), the signs for the defense county dummy variable ($DEFDV_j$), the lagged change in energy cost ($STNRGYCH_{j,t-1}$), the change in state and local government employment ($SLGCHG_{jt}$), and the lagged change in population density ($DNSITYCH_{j,t-1}$) are opposite of both their expected signs and the results obtained when $EMPCHG_{j,t-2}$ is used as the instrument. Furthermore, the coefficient estimate of 1.31 for $EMP_{j,t-2}$ is counterintuitive given this represents $1-\lambda$ (recall in a partial adjustment model, the value of λ is constrained such that $0 \leq \lambda \leq 1$).

Examination of the correlation between these two instruments and the lagged dependent variable reveals $EMPCHG_{j,t-2}$ is the better choice. Specifically, neither instrument is contemporaneously correlated with the disturbance term, but r_{xy} for $EMPCHG_{j,t-2}$ and $EMPCHG_{j,t-1}$ is 0.718, whereas the correlation coefficient for $EMP_{j,t-2}$ and $EMPCHG_{j,t-2}$ is 0.466. Keeping with Kmenta (1997) then, the size of the variance-covariance matrix is minimized through the choice of $EMPCHG_{j,t-2}$. The larger variance under the $EMP_{j,t-2}$ instrument likely explains the disparities above. Consequently, through the remainder of the study, $EMPCHG_{j,t-2}$ serves as the instrumental variable remedy for lagged dependent variable concerns.

Table 8 – *Changes* Model with Lagged Dependent Variable Instruments

Dependent Variable: $\mathbf{EMPCHG_{jt}}$

$\mathbf{EMPCHG^*_{j,t-1}}$ **Instrument:** $\mathbf{EMPCHG_{j,t-2}}$	Coeff	T-Stat		$\mathbf{EMPCHG^*_{j,t-1}}$ **Instrument:** $\mathbf{EMP_{j,t-2}}$	Coeff	T-Stat	
Λ_t	not shown			Λ_t	not shown		
$DEFCHG_{jt}$	-0.21	-3.79	**	$DEFCHG_{jt}$	-0.45	-8.51	**
$DEFDV_j$	1741.97	28.75	**	$DEFDV_j$	-170.00	-2.29	*
$LANDCHG_{jt}$	1.71	6.40	**	$LANDCHG_{jt}$	1.81	6.90	**
$STNRGYCH_{i,t-1}$	-35.47	-0.88		$STNRGYCH_{i,t-1}$	38.92	1.05	
$PPICHG_{j,t-1}$	299.99	5.73	**	$PPICHG_{j,t-1}$	1304.00	25.61	**
$SLGCHG_{jt}$	1.47	38.20	**	$SLGCHG_{jt}$	-2.52	-36.07	**
$PCIMBPCH_{i,t-1}$	0.09	0.17		$PCIMBPCH_{i,t-1}$	9.15	17.14	**
$PWRCHG_{j,t-1}$	120.79	7.11	**	$PWRCHG_{j,t-1}$	45.99	2.92	*
$PCFEACHG_{j,t-1}$	3.08	2.67	**	$PCFEACHG_{j,t-1}$	10.11	9.53	**
$DNSITYCH_{i,t-1}$	12356.80	15.54	**	$DNSITYCH_{i,t-1}$	-9074.75	-10.82	**
$PSRVCCHG_{j,t-1}$	554.34	0.75		$PSRVCCHG_{j,t-1}$	2148.98	3.13	*
$POPECHG_{j,t-1}$	1223.94	2.16	*	$POPECHG_{j,t-1}$	3009.45	5.74	**
$CSCHG_{i,t-1}$	-3922.29	-4.63	**	$CSCHG_{i,t-1}$	-11221.20	-14.19	**
$FARMCHG_{jt}$	0.89	8.24	**	$FARMCHG_{jt}$	1.25	12.45	**
$\mathbf{EMPCHG_{j,t-2}}$	0.26	40.60	**	$\mathbf{EMP_{j,t-2}}$	1.31	72.35	**
Final est. of Rho	0.52	145.90	**	Final est. of Rho	0.56	165.54	**

(counties, n = 3092; periods, T = 19)

* Significant at the 95 percent level.

** Significant at the 99 percent level.

Notes: 1. Observed values for the instruments $EMPCHG_{j,t-2}$ and $EMP_{j,t-2}$ represent the fitted values for $EMPCHG_{j,t-1}$ when it is regressed on the original independent variables and the respective instrument is substituted for $EMPCHG_{j,t-1}$ on the right-hand side (the equation and results when the instrument is EMPCHGj,t-2 is provided in Appendix B).

2. Models corrected for first order autocorrelation.

When compared with the *Changes* model before instruments (Table 7), the differences in results with $EMPCHG_{j,t-2}$ as the lagged dependent variable instrument are fairly minor. For example, the negative amenity proxy, lagged change in per capita income maintenance benefit payments ($PCIMBPCH_{j,t-1}$) is the only variable that reverses sign. But in both cases, this coefficient tests insignificant. The remaining variables have the expected signs in both models, with the exception of the primary variable of interest, $DEFCHG_{jt}$. Again, its upcoming decomposition into positives and negative elements allows closer scrutiny. Only the cost of living proxy, lagged change in energy cost ($STNRGYCH_{j,t-1}$), loses its significance moving from the lagged dependent variable model to the instrumental variable variation. Finally, the move to the instrumental variable model doubles the magnitude of the defense county effect.

Decomposition of Personnel Changes and "Closure Clocks"

Though model specifications thus far facilitate examination of Proposition (1), in principle, the counterintuitive results realized and Proposition (2) necessitate dissection, or decomposition of the defense personnel changes variable into its positive and negative elements. What's more, Proposition (3) can be better explored by dividing the negative personnel changes into two subcategories: those related to on-going defense operations, and those tied directly to base closures. The resulting three defense personnel change variables are defined in Table 9.

Table 9 – Decomposed Defense Variables

Variable	Definition
$PDEFCHG_{jt}$	Positive changes (i.e., increases) in military and defense federal civilian employment from year t-1 to year t. Observed values for this variable are always ≥ 0.
$NDEFCHG_{jt}$	Ordinary (non-BRAC related) negative changes in military and defense federal civilian employment from year t-1 to year t. Observed values for this variable are always ≤ 0.
$BDEFCHG_{jt}$	BRAC related changes in military and defense federal civilian employment from year t-1 to year t. Nonzero values are reflected for this variable beginning the first year following the corresponding BRAC *when levels begin to draw down*, and thereafter. Observed values are always ≤ 0.

Notes: 1. Measures are at the county level
2. j denotes county j
3. t denotes year t

Another noteworthy consideration is the effect of psychic shock associated with base closure selection and announcement. There is substantial anecdotal evidence of adverse reactions to these events. For example, Dardia et. al. (1995) contains a number of pessimistic forecasts developed by community leaders of effected areas in California. Kitfield (1995) paints a bleak picture of San Antonio's shock over the announcement to close the depot at Kelly AFB. The *Economist* reports Sacramento's response to the selection of McClellan AFB is akin to rats leaving a sinking ship: "Many people are already trying to sell [their homes] before the flood of surplus houses hits the market."[45] While there is no

[45] See "The McClellan Factor," 1995.

widespread evidence to suggest closure communities on the whole faired poorly or dried up as anticipated, it is conceivable that businesses on the verge of starting up or locating in these communities at the time of announcement may have shared similar fears and delayed, or curtailed their plans. One way to capture this psychic shock effect is via a "closure clock" dummy variable regime. Specifically, a series of county-level dummies marking the year of base closure announcement, and the subsequent five years is examined.[46] The purpose of these dummies is to capture the effects of unobservable BRAC factors such as community apprehension and optimism. Also embedded in these dummy variables is the effect of over one billion dollars in BRAC related federal economic relief for which details could not be obtained.[47] Exploration of this dummy regime was deferred until this point since these variables cannot be strictly transformed between the *Levels* and *Changes* modeling forms without losing economic meaning. The "closure clock" dummies are defined in Table 10.

A firm basis does not exist for detailed expectations of signs and magnitudes for each of these dummy variables; only relative generalities can be made. Assuming media descriptions accurately reflect community anxiety, negative coefficients are expected for the first few years. But, as anxiety gives way to less-than-disastrous reality, and as community assistance arrives, these variables likely become less negative, or even positive where they capture

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[46] Under base closure law, BRAC actions had to be completed within six years of a given base's selection. The Tn_{jt} dummy regime covers that interval.

[47] See discussion of Economic Relief, beginning on page 21.

Table 10 – BRAC "Closure Clock" Dummy Variables

Variable	Definition
$T0_{jt}$	Dummy variable which takes a value of 1 if county j hosts a BRAC installation *and* t is the year this county first came under BRAC; otherwise T_{jt} = 0.
Tn_{jt}	Dummy variables (n = 1 to 5) which take a value of 1 if county j hosts a BRAC installation *and* t is the n^{th} year after this county came under BRAC; otherwise Tn_{jt} = 0.

Notes: 1. j denotes county j
2. t denotes year t

reutilization phenomena not reflected in the *installation reutilization proxy,* $LANDCHG_{jt}$.

Substituting $PDEFCHG_{jt}$, $NDEFCHG_{jt}$, and $BDEFCHG_{jt}$ for $DEFCHG_{jt}$; adding the "closure clock" dummy regime; and employing $EMPCHG_{j,t-2}$ as the instrumental variable for $EMPCHG_{j,t-1}$ (denoted $EMPCHG^*_{j,t-1}$) yields the specification presented in equation (12). Results of the decomposed defense personnel changes model, with and without the "closure clock" dummy regime, are presented in Table 11.

With the exception of the BRAC related personnel change variable ($BDEFCHG_{j,t}$), the inclusion of a BRAC dummy regime does not appear to materially affect the other variables when the two models of Table 11 are compared. The anticipated outcome for the "closure clock" variables is more or less realized. Specifically, negative employment effects characterize the first year following announcement. This is in line with conjectures of community

$$
\begin{array}{lll}
EMPCHG_{jt} = \Lambda_t & & (12) \\
+ \lambda\beta_{1a}PDEFCHG_{jt} & \lambda\beta_{1a} > 0 & \\
+ \lambda\beta_{1b}NDEFCHG_{jt} & \lambda\beta_{1b} < 0 & \\
+ \lambda\beta_{1c}BDEFCHG_{jt} & \lambda\beta_{1c} < 0 & \\
+ \lambda\beta_{2}DEFDV_{j} & \lambda\beta_{2} > 0 & \\
+ \lambda\beta_{3}LANDCHG_{jt} & \lambda\beta_{3} > 0 & \\
+ \lambda\beta_{4}T0_{jt} & \lambda\beta_{4} \quad ? & \\
+ \lambda\beta_{5}T1_{jt} & \lambda\beta_{5} \quad ? & \\
+ \lambda\beta_{6}T2_{jt} & \lambda\beta_{6} \quad ? & \\
+ \lambda\beta_{7}T3_{jt} & \lambda\beta_{7} \quad ? & \\
+ \lambda\beta_{8}T4_{jt} & \lambda\beta_{8} \quad ? & \\
+ \lambda\beta_{9}T5_{jt} & \lambda\beta_{9} \quad ? & \\
+ \lambda\gamma_{1}STNRGYCH_{j,t-1} & \lambda\gamma_{1} < 0 & \\
+ \lambda\gamma_{2}PPICHG_{j,t-1} & \lambda\gamma_{2} > 0 & \\
+ \lambda\gamma_{3}SLGCHG_{jt} & \lambda\gamma_{3} > 0 & \\
+ \lambda\gamma_{4}PCIMBPCH_{j,t-1} & \lambda\gamma_{4} < 0 & \\
+ \lambda\gamma_{5}PWRCHG_{j,t-1} & \lambda\gamma_{5} > 0 & \\
+ \lambda\gamma_{6}PCFEACHG_{j,t-1} & \lambda\gamma_{6} > 0 & \\
+ \lambda\gamma_{7}DNSITYCH_{j,t-1} & \lambda\gamma_{7} > 0 & \\
+ \lambda\gamma_{8}PSRVCCHG_{j,t-1} & \lambda\gamma_{8} > 0 & \\
+ \lambda\gamma_{9}POPECHG_{j,t-1} & \lambda\gamma_{9} > 0 & \\
+ \lambda\gamma_{10}CSCHG_{j,t-1} & \lambda\gamma_{10} < 0 & \\
+ \lambda\gamma_{11}FARMCHG_{jt} & \lambda\gamma_{11} > 0 & \\
+ (1-\lambda)\ EMPCHG^{*}_{j,t-1} & (1-\lambda) > 0 & \\
+ e_{jt} & &
\end{array}
$$

Table 11 – Decomposed *Changes* Model and "Closure Clock" Dummies

Dependent Variable: **$EMPCHG_{jt}$**

	Decomposed Defense		Decomposed Defense with "Closure Clock" Dummies	
	Coeff	T-Stat	Coeff	T-Stat
Λ_t	not shown		not shown	
$PDEFCHG_{jt}$	0.48	4.75 **	0.48	4.79 **
$NDEFCHG_{jt}$	-0.68	-7.48 **	-0.67	-7.35 **
$BDEFCHG_{jt}$	-0.96	-5.36 **	-0.60	-3.08 **
$DEFDV_j$	1630.56	26.42 **	1582.35	25.46 **
$LANDCHG_{j,t}$	1.17	3.96 **	1.22	4.11 **
$T0_{jt}$			152.38	0.46
$T1_{jt}$			-548.21	-1.47
$T2_{jt}$			1608.67	4.23 **
$T3_{jt}$			1079.60	2.33 *
$T4_{jt}$			4741.70	10.76 **
$T5_{jt}$			1731.74	3.27 **
$STNRGYCH_{j,t-1}$	-34.37	-0.85	-33.89	-0.84
$PPICHG_{j,t-1}$	297.64	5.68 **	295.07	5.64 **
$SLGCHG_{jt}$	1.46	38.02 **	1.46	37.98 **
$PCIMBPCH_{j,t-1}$	0.07	0.12	0.09	0.16
$PWRCHG1L_{j,t-1}$	121.06	7.13 **	120.45	7.10 **
$PCFEACHG_{j,t-1}$	3.08	2.68 **	3.06	2.66 **
$DNSITYCH_{j,t-1}$	12354.30	15.54 **	12313.60	15.51 **
$PSRVCHG_{j,t-1}$	568.77	0.77	596.70	0.80
$POPECHG_{j,t-1}$	1239.01	2.18 *	1264.74	2.23 *
$CSCHG_{j,t-1}$	-3917.27	-4.63 **	-3924.61	-4.64 **
$FARMCHG_{jt}$	0.90	8.35 **	0.86	7.97 **
$EMPCHG^*_{j,t-1}$ (IV: $EMPCHG_{j,t-2}$)	0.26	40.64 **	0.26	40.41 **
Final est. of Rho	0.51	145.42 **	0.51	145.06 **

(counties, n = 3092; periods, T = 19)

* Significant at the 95 percent level.

** Significant at the 99 percent level.

Note: Models corrected for first order autocorrelation.

apprehension, and uncertainty on the part of business planners. However, coefficients for the announcement year and the subsequent year do not test significantly different from 0. Years two through five reflect positive and significant employment effects, with year four being most pronounced. It may be that year four at closure sites typically marks the peak for returns on reutilization and economic assistance measures (recall for BRACs '88 and '91, time to closure averaged between 5 ½ and 3 ½ years, respectively).

In moving from the consolidated *defense change* equivalent on the left side of Table 8, to the decomposed models of Table 11, the signs and significance for installation reutilization ($LANDCHG_{j,t}$) and the control variables remain unchanged. Again, only the coefficient of the lagged change in per capita income maintenance benefit payments variable ($PCIMBPCH_{j,t-1}$) is opposite the expected direction. But, like the lagged change in state-level energy costs and percent change in service industry employment variables ($STNRGYCH_{j,t-1}$ and $PSRVCHG_{j,t-1}$), this one still does not test significant. Nonetheless, all three of these are retained with the belief they are relevant industry location and migration determinants.

A closer look at the relationship between percent change in other private employment ($POPECHG_{j,t-1}$) and percent change in service industry employment ($PSRVCHG_{j,t-1}$) may offer some insight into why the apparent effect of the latter on non-farm private employment is insignificant. To begin with, these two independent variables are highly, and negatively correlated (r = -0.540). With regard to regional industry restructuring only, this negative relationship stands to

reason; the third sector (manufacturing) cannot be expected to bear all the shifts into and out of the other two sectors (i.e., gains to services may come at the expense of losses to non-farm private employment sectors other than manufacturing).

The numbers behind Figure 3 offer some quantitative clarification. From 1977 to 1997, non-farm private employment in the U.S. grew 57%. Within the service industry, employment growth for the same period was more than double the overall rate (120%). At the same time, manufacturing declined 4%, while the remaining sectors grew 35% in aggregate. The relative magnitudes of these values suggest percent change in other private employment is a viable predictor of regional growth. For example, through simple extrapolation of the numbers above, one might reasonably hypothesize a 1% increase in other private employment leads to employment increases across services and manufacturing combined, by up to 0.63% [1 – (0.57/0.35)]. On the other hand, these growth trends make it difficult to develop a similar hypothesis for service industry employment. Clearly, a substantial amount of the growth in services is due to industry restructuring, rather than all new employment. Therefore, this variable is a weak indicator since it embodies both these effects, with the former effect being very pronounced. That does not necessarily preclude the use of a percent change in service industry employment variable. But it does imply the effects of the two industry structure variables should be viewed together, rather than in isolation.

Interestingly, the decomposition of the defense personnel change variable has very little impact on the remaining variables. As stated, the signs and significance test results are unchanged. Furthermore, the magnitudes of the control variables generally vary by less than one percent. Only the coefficient of the installation reutilization variable ($LANDCHG_{j,t}$) varies appreciably, decreasing from an estimated effect of 1.71 jobs gained per parceled acre, to 1.17.

The three defense personnel change variables, $PDEFCHG_{jt}$, $NDEFCHG_{jt}$, and $BDEFCHG_{jt}$ all have the expected signs. Specifically, the positive coefficient for $PDEFCHG_{jt}$ supports Proposition (1): increases in military base labor force levels spur demand driven positive indirect employment effects in the surrounding communities. The magnitude of the coefficient suggests these indirect employment effects are on the order of 0.48 (e.g., in the short run, 100 new defense jobs create 48 new civilian jobs, for a net gain of 148 jobs). The negative coefficient for $NDEFCHG_{jt}$ supports Proposition (2): supply driven factors such as freed labor and community infrastructure under routine (i.e., non-BRAC) draw downs yield positive employment pressures on local communities. This outcome is defended, in part, by the labor force redistributive effects of defense dynamics, as discussed on page 43.

At first glance, the negative defense change ($NDEFCHG_{jt}$) coefficient value of -0.67 in the "closure clock" model of Table 11 appears excessive – especially relative to the coefficient value of 0.48 for positive defense changes ($PDEFCHG_{jt}$). But looking back at Figure 1 on page 9, it should be noted the period of review (i.e., 1977-1997) covered defense personnel shifts *after* the manning peak of

1968, at which time defense infrastructure adequately supported 4.9 million personnel. So in many cases, positive defense personnel changes involved reutilizing existing, but idle public facilities. Consequently, the coefficient for $PDEFCHG_{jt}$ is dampened compared to what may have been realized if all personnel increases during this period necessitated the construction and upkeep of completely new facilities. At the same time, defense personnel downsizing during this period did not always translate to defense spending decreases. This becomes evident in Figure 8, where the mid-70's through late 80's experienced disproportionate growth in spending.

The concept of outsourcing defense operations, which came into vogue during in the early 80's, can help explain the divergence between defense personnel levels and spending in Figure 8. In short, the DoD began transferring functions not considered inherently governmental from their federal employees to defense contractors. As a uniformed member walked out the door one day, a defense industry employee who fulfilled the same function (often the same individual) replaced the defense worker shortly thereafter. While incorporation of related spending data would certainly control for these effects, regrettably such data are not available. Specifically, current summary records only track these expenditures to the point of payment (e.g., the prime contractor's corporate headquarters), which may differ from the benefiting community, or even state. This limitation is duly noted in a number of related studies (e.g., Hooker and Knetter, 1997; Brauer and Marlin, 1992; Cumberland, 1973). Under similar circumstances, -0.67 is probably representative of the effects of non-BRAC

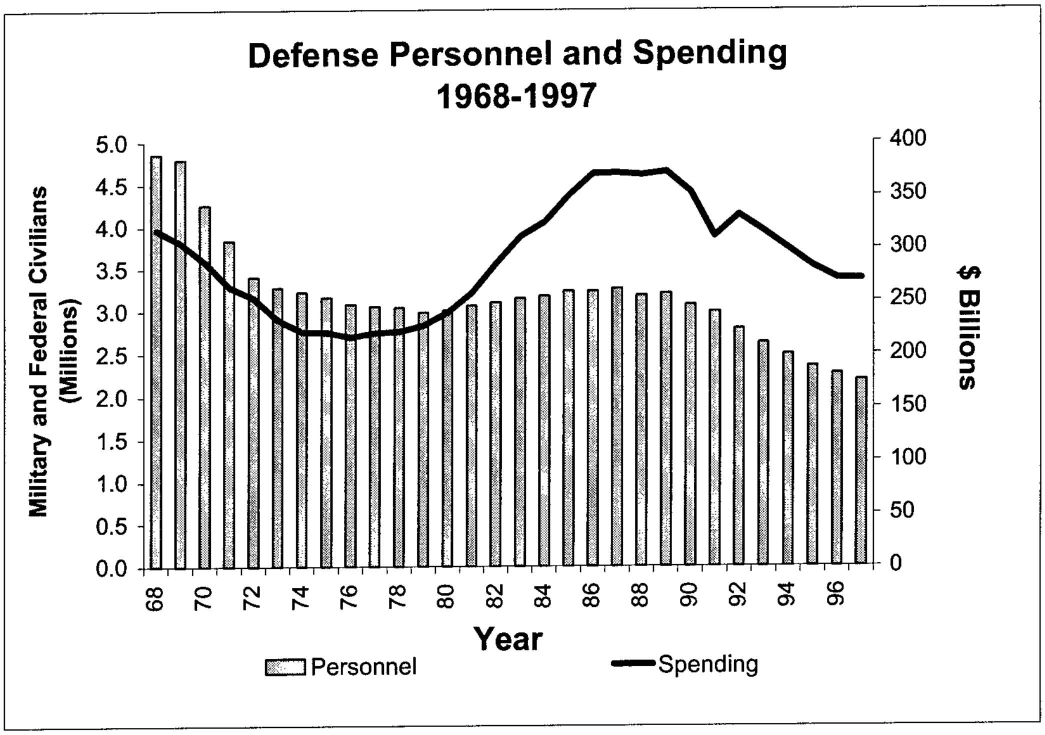

Figure 8 - Defense Personnel vs. Spending

defense personnel downsizing actions. But in the case of downsizing "without substitution," this estimate is likely biased upward in magnitude. Nonetheless, the redistributive effects of defense labor force dynamics and other factors related to downsizing -- such as suppressed rents, decrease property values, and excess labor supply -- are certain to exert favorable industry location and employment pressures.

The results for the *BRAC related personnel reductions* ($BDEFCHG_{jt}$), along with the *installation reutilization proxy* ($LANDCHG_{jt}$) support Proposition (3). Specifically, the negative sign for $BDEFCHG_{jt}$, coupled with the positive sign for

$LANDCHG_{jt}$ imply base closure impacts are mitigated to some extent by the community infrastructure vacuum created through departure of military residents, and by efforts to promote private reutilization of otherwise idle defense facilities. The magnitude of the $LANDCHG_{jt}$ coefficient is about the same across both models in Table 11, again suggesting short run effects are 6 new jobs created for every 5 acres of reutilized land. In the "closure clock" dummy variable model of Table 11, the magnitude of the $BDEFCHG_{jt}$ coefficient estimate drops substantially, from -0.96 to -0.60. It appears $BDEFCHG_{jt}$ was picking up some of the effects of state and federal economic aid before inclusion of the "closure clock" dummy regime.

The observations in the data set reflect total acreage released as of November 2000, allocated across the preceding periods, in proportion to *BRAC related personnel reductions*. Consequently, $LANDCHG_{jt}$ and $BDEFCHG_{jt}$ are highly correlated. Given this approach assumes facilities were released immediately as they became available, yet media reports and OEA records suggest substantial delays were involved, examination of lagged $LANDCHG_{jt}$ values may alleviate some of the collinearity problem while painting a more realistic picture of actual events. This avenue is explored next.

Lagged Installation Reutilization Proxies

The second model of Table 11 is rerun with the installation reutilization proxy, $LANDCHG_{jt}$, lagged one, two, then three periods to examine the role of delays in facility conveyance efforts. The results of these three models are

presented in Table 12. While size, significance, and signs of the control variables do not change markedly, in all three models the absolute magnitude of $BDEFCHG_{jt}$ increases somewhat (from -0.60 in Table 11, to -0.87, -1.01, and -0.87 in the respective first, second, and third lag models of Table 12). In the absence of details regarding the actual pattern of conveyance delays, the third lag model ($LANDCHG_{j,t-3}$) is the model of choice as more "closure clock" dummies test significant in this specification than under the other three models. The implicit assumption is that typically three years lapse before excessed military land and facilities are put to productive private use.

The $LANDCHG_{j,t-3}$ model suggests the apprehension of closure announcement represents a brief hiccup. The immediate release, or decongestion of community infrastructure and housing, and the local surplus of labor act to counter the apprehension, as businesses recognize an opportunity for low cost startup, expansion, and production. The magnitude of $BDEFCHG_{jt}$ suggests this occurs at a rate of 0.87 new jobs for every BRAC related job loss. At the same time, private reutilization of defense facilities translates to around two new jobs for every acre conveyed, though conveyance typically entails a three-year delay, during which facilities remain idle. Finally, the effects of aid related opportunism typically peak in the fourth year.

Industry Specialization and Defense-to-Labor Force Interactions

Propositions (4) and (5) examine the elasticities of the defense employment effects modeled thus far, to regional industry structure and labor

Table 12 – Examination of Lagged Base Reutilization Proxies

Dependent Variable: **$EMPCHG_{jt}$**

	$LANDCHG_{j,t-1}$		**$LANDCHG_{j,t-2}$**		**$LANDCHG_{j,t-3}$**	
	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Λ_t	not shown		not shown		not shown	
$PDEFCHG_{jt}$	0.48	4.76 **	0.49	4.80 **	0.49	4.81 **
$NDEFCHG_{jt}$	-0.66	-7.27 **	-0.67	-7.32 **	-0.68	-7.42 **
$BDEFCHG_{jt}$	-0.87	-4.88 **	-1.01	-5.72 **	-0.87	-4.88 **
$DEFDV_j$	1578.16	25.40 **	1572.53	25.31 **	1572.85	25.31 **
$LANDCHG_{j,?}$	1.62	5.97 **	2.31	8.84 **	2.05	5.66 **
$T0_{jt}$	159.13	0.48	158.55	0.47	154.47	0.46
$T1_{jt}$	-472.92	-1.27	-543.29	-1.46	-472.47	-1.27
$T2_{jt}$	1457.28	3.83 **	1602.58	4.22 **	1710.33	4.50 **
$T3_{jt}$	711.16	1.52	569.44	1.22	1221.33	2.63 **
$T4_{jt}$	4355.07	9.79 **	4032.03	9.01 **	4459.68	10.06 **
$T5_{jt}$	1649.99	3.11 **	1162.35	2.17 *	1552.28	2.91 **
$STNRGYCH_{j,t-1}$	-32.92	-0.82	-32.89	-0.82	-32.48	-0.81
$PPICHG_{j,t-1}$	295.63	5.65 **	294.37	5.63 **	293.74	5.61 **
$SLGCHG_{jt}$	1.45	37.90 **	1.46	38.13 **	1.46	38.05 **
$PCIMBPCH_{j,t-1}$	0.06	0.11	0.06	0.11	0.09	0.17
$PWRCHG1L_{j,t-1}$	120.27	7.09 **	120.09	7.08 **	120.12	7.08 **
$PCFEACHG_{j,t-1}$	3.04	2.64 **	3.05	2.65 **	3.05	2.65 **
$DNSITYCH_{j,t-1}$	12367.00	15.59 **	12388.90	15.62 **	12358.00	15.58 **
$PSRVCHG_{j,t-1}$	587.96	0.79	601.88	0.81	592.66	0.80
$POPECHG_{j,t-1}$	1263.57	2.23 *	1261.60	2.23 *	1265.94	2.23 *
$CSCHG_{j,t-1}$	-3937.52	-4.65 **	-3919.87	-4.64 **	-3926.07	-4.64 **
$FARMCHG_{jt}$	0.85	7.91 **	0.87	8.04 **	0.88	8.12 **
$EMPCHG^*_{j,t-1}$ (IV: $EMPCHG_{j,t-2}$)	0.26	40.45 **	0.26	40.18 **	0.26	40.19 **
Final est. of Rho	0.51	144.94 **	0.51	145.08 **	0.51	144.90 **

(counties, n = 3092; periods, T = 19)

* Significant at the 95 percent level.
** Significant at the 99 percent level.
Note: Models corrected for first order autocorrelation.

force size relative to defense presence. Specifically, Proposition (4) states that regions with highly specialized industry are less sensitive to military base employment changes because these regions likely thrive on export activities. Proposition (5) states base employment effects are more pronounced in regions with relatively smaller non-defense employment because these regions are less likely to have achieved their full potential for scale economies. To accommodate examination of these propositions, the model in equation (12) is modified with interaction terms. Specifically, equation (13) incorporates lagged values of the changes in industry specialization ($CSCHG_{j,t-1}$) and defense-to-labor force ratio ($D2LFCHG_{j,t-1}$).[48]

The expectations that support propositions (4) and (5) can also be expressed in simple form through the first derivative of the dependent variable with respect to each element of the decomposed *defense personnel change* variable. This form is presented in equations (14) through (16), along with expectations of the overall signs.

Note that a lagged value of the change in defense-to-labor force ratio ($D2LFCHG_{j,t-1}$) is included in equation (13) as a stand alone variable. This is to gauge if the significance of the combined term is driven purely by the interaction component (as noted previously, $CSCHG_{j,t-1}$ is already in the model as an industry

[48] This specification of the interactions cannot be literally transformed back to the *Levels* form of the model with economic meaning. Keeping with the intent of developing a true *Changes* model, the interactions are modeled with *changes* rather *levels* for these two terms. The interpretation of these lagged terms still holds. For example, *increases* in industry specialization and *decreases* in the ratio of defense personnel to the local labor force are expected to dampen the effects of the primary variable ($PDEFCHG_{jt}$, $NDEFCHG_{jt}$, or $BDEFCHG_{jt}$, as the case may be).

$$
\begin{aligned}
EMPCHG_{jt} \quad &= \Lambda_t && && (13)\\
&+ \lambda\beta_{1a}PDEFCHG_{jt} && \lambda\beta_{1a} > 0\\
&+ \lambda\beta_{1b}PDEFCHG_{jt}{*}CSCHG_{j,t-1} && \lambda\beta_{1b} < 0\\
&+ \lambda\beta_{1c}PDEFCHG_{jt}{*}D2LFCHG_{j,t-1} && \lambda\beta_{1c} > 0\\
&+ \lambda\beta_{1d}NDEFCHG_{jt} && \lambda\beta_{1d} < 0\\
&+ \lambda\beta_{1e}NDEFCHG_{jt}{*}CSCHG_{j,t-1} && \lambda\beta_{1e} > 0\\
&+ \lambda\beta_{1f}NDEFCHG_{jt}{*}D2LFCHG_{j,t-1} && \lambda\beta_{1f} < 0\\
&+ \lambda\beta_{1g}BDEFCHG_{jt} && \lambda\beta_{1g} < 0\\
&+ \lambda\beta_{1h}BDEFCHG_{jt}{*}CSCHG_{j,t-1} && \lambda\beta_{1h} > 0\\
&+ \lambda\beta_{1i}BDEFCHG_{jt}{*}D2LFCHG_{j,t-1} && \lambda\beta_{1i} < 0\\
&+ \lambda\beta_{2}DEFDV_{j} && \lambda\beta_{2} > 0\\
&+ \lambda\beta_{3}LANDCHG_{j,t-3} && \lambda\beta_{3} > 0\\
&+ \lambda\beta_{4}T0_{jt} && \lambda\beta_{4} \quad ?\\
&+ \lambda\beta_{5}T1_{jt} && \lambda\beta_{5} \quad ?\\
&+ \lambda\beta_{6}T2_{jt} && \lambda\beta_{6} \quad ?\\
&+ \lambda\beta_{7}T3_{jt} && \lambda\beta_{7} \quad ?\\
&+ \lambda\beta_{8}T4_{jt} && \lambda\beta_{8} \quad ?\\
&+ \lambda\beta_{9}T5_{jt} && \lambda\beta_{9} \quad ?\\
&+ \lambda\beta_{10}D2LFCHG_{j,t-1} && \lambda\beta_{10} \quad ?\\
&+ \lambda\gamma_{1}STNRGYCH_{j,t-1} && \lambda\gamma_{1} < 0\\
&+ \lambda\gamma_{2}PPICHG_{j,t-1} && \lambda\gamma_{2} > 0\\
&+ \lambda\gamma_{3}SLGCHG_{jt} && \lambda\gamma_{3} > 0\\
&+ \lambda\gamma_{4}PCIMBPCH_{j,t-1} && \lambda\gamma_{4} < 0\\
&+ \lambda\gamma_{5}PWRCHG_{j,t-1} && \lambda\gamma_{5} > 0\\
&+ \lambda\gamma_{6}PCFEACHG_{j,t-1} && \lambda\gamma_{6} > 0\\
&+ \lambda\gamma_{7}DNSITYCH_{j,t-1} && \lambda\gamma_{7} > 0\\
&+ \lambda\gamma_{8}PSRVCCHG_{j,t-1} && \lambda\gamma_{8} > 0\\
&+ \lambda\gamma_{9}POPECHG_{j,t-1} && \lambda\gamma_{9} > 0\\
&+ \lambda\gamma_{10}CSCHG_{j,t-1} && \lambda\gamma_{10} < 0\\
&+ \lambda\gamma_{11}FARMCHG_{jt} && \lambda\gamma_{11} > 0\\
&+ \lambda\gamma_{12}CS_{j,t-1} && \lambda\gamma_{12} < 0\\
&+ (1-\lambda)EMPCHG^{*}_{j,t-2} && (1-\lambda) > 0\\
&+ e_{jt}
\end{aligned}
$$

$\partial EMPCHG_{jt}/\partial PDEFCHG_{jt}$

$$= \underset{(+)}{\lambda\beta_{1a}} + \underset{(-)}{\lambda\beta_{1b}}CSCHG_{j,t-1} + \underset{(+)}{\lambda\beta_{1c}}D2LFCHG_{j,t-1} > 0 \qquad (14)$$

$\partial EMPCHG_{jt}/\partial NDEFCHG_{jt}$

$$= \underset{(-)}{\lambda\beta_{1d}} + \underset{(+)}{\lambda\beta_{1e}}CSCHG_{j,t-1} + \underset{(-)}{\lambda\beta_{1f}}D2LFCHG_{j,t-1} < 0 \qquad (15)$$

$\partial EMPCHG_{jt}/\partial BDEFCHG_{jt}$

$$= \underset{(-)}{\lambda\beta_{1g}} + \underset{(+)}{\lambda\beta_{1h}}CSCHG_{j,t-1} + \underset{(-)}{\lambda\beta_{1i}}D2LFCHG_{j,t-1} < 0 \qquad (16)$$

location control variable). A priori arguments cannot be made either way about the direction of $D2LFCHG_{j,t-1}$, so this stand alone variable carries no anticipated sign. The results of the decomposed *Changes* model with "closure clock" dummies, a three-year lagged installation reutilization proxy ($LANDCHG_{j,t-3}$), and interaction terms are presented in Table 13.

The first thing that becomes apparent from Table 13 is that significance, signs, and magnitudes for the non-defense variable coefficients are not materially different after inclusion of the interaction terms. Secondly, the signs for $PDEFCHG_{jt}*CSCHG_{j,t-1}$, $NDEFCHG_{jt}*CSCHG_{j,t-1}$, and $BDEFCHG_{jt}*D2LFCHG_{j,t-1}$ are consistent with Propositions (4) and (5). However, with the exception of $BDEFCHG_{jt}*D2LFCHG_{j,t-1}$, none of the interaction terms test significantly different from zero in magnitude. This suggests changes in the local defense-to-labor

Table 13 – Examination of Lagged Interaction Terms

Dependent Variable: $\mathbf{EMPCHG_{jt}}$

	Coeff	T-Stat
Λ_t	not shown	
$PDEFCHG_{jt}$	0.48	4.68 **
$\mathbf{PDEFCHG_{jt}*CSCHG_{i,t-1}}$	-1.66	-0.16
$\mathbf{PDEFCHG_{jt}*D2LFCHG_{i,t-1}}$	-0.25	-0.95
$NDEFCHG_{jt}$	-0.68	-7.45 **
$\mathbf{NDEFCHG_{jt}*CSCHG_{i,t-1}}$	0.32	0.12
$\mathbf{NDEFCHG_{jt}*D2LFCHG_{i,t-1}}$	0.07	0.17
$BDEFCHG_{jt}$	-1.06	-5.62 **
$\mathbf{BDEFCHG_{jt}*CSCHG_{i,t-1}}$	-10.13	-0.47
$\mathbf{BDEFCHG_{jt}*D2LFCHG_{i,t-1}}$	-24.87	-3.49 **
$DEFDV_j$	1568.47	25.27 **
$LANDCHG_{i,t-3}$	2.01	5.54 **
$T0_{jt}$	150.56	0.45
$T1_{jt}$	-393.07	-1.05
$T2_{jt}$	1814.93	4.74 **
$T3_{jt}$	1283.22	2.76 **
$T4_{jt}$	4564.59	10.26 **
$T5_{jt}$	1567.47	2.94 **
$\mathbf{D2LFCHG_{i,t-1}}$	22.32	2.89 **
$STNRGYCH_{j,t-1}$	-32.78	-0.81
$PPICHG_{i,t-1}$	292.90	5.60 **
$SLGCHG_{jt}$	1.46	38.02 **
$PCIMBPCH_{j,t-1}$	0.10	0.17
$PWRCHG1L_{j,t-1}$	119.86	7.06 **
$PCFEACHG_{i,t-1}$	3.06	2.66 **
$DNSITYCH_{i,t-1}$	12353.90	15.57 **
$PSRVCHG_{j,t-1}$	610.32	0.82
$POPECHG_{j,t-1}$	1270.70	2.24 *
$\mathbf{CSCHG_{i,t-1}}$	-3933.71	-4.64 **
$FARMCHG_{it}$	0.89	8.26 **
$EMPCHG^*_{j,t-1}$ (IV: $EMPCHG_{j,t-2}$)	0.26	40.38 **
Final est. of Rho	0.51	144.60 **

(counties, n = 3092; periods, T = 19)

* Significant at the 95 percent level
** Significant at the 99 percent level
Note: Model corrected for first order autocorrelation

force ratio materially influence the impact of defense personnel reductions. Specifically, as this ratio becomes smaller, the favorable employment effects of BRAC (i.e., freed labor and community infrastructure, and base facilities reutilization) become less pronounced.[49] The insignificance of the other five interactions suggests changes in the degree of regional industry specialization do not materially influence the effects of defense personnel changes on local employment. Likewise, county level employment effects of ordinary defense workforce expansions and contractions are not sensitive to changes in the local defense-to-labor force ratio.

As expected, the stand-alone variable representing lagged change in the coefficient of specialization is negative and significant, implying specialized regions do not generally fair as well as those that are diversified. The coefficient for the stand-alone lagged change in defense-to-labor force ratio ($D2LFCHG_{j,t-1}$) is positive and significant. Coupled with the results for the $BDEFCHG_{jt}*D2LFCHG_{j,t-1}$ interaction term, this seems to suggest employment in counties with a greater military presence tends to grow at a faster rate than that of counties with little or no military presence. This conclusion lends little support to the Hooker and Knetter (1999) argument that military salaries bring down community earnings averages. If that were truly the case, the hypothesized

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[49] In general, BRAC related downsizing implies the local defense-to-labor force ratio is decreasing, so observed values of $D2LFCHG_{j,t-1}$ should be negative. In fact, where BRAC related personnel changes occurred the mean value for $D2LFCHG_{j,t-1}$ was -0.009.

lower average earnings should translate to smaller induced employment effects, rather than faster growth.

Given the many interaction terms of the model in Table 13, it is difficult to interpret the overall employment effects of military bases without some computation involving the three components for each type of defense personnel change (refer to equations (14), (15), and (16) on page 109). This is particularly true in the case of BRAC related personnel changes, since one of the interaction terms tests significantly different from 0. To address this concern, the coefficient estimates from Table 13 are multiplied with observed values of the interaction terms, then summed, resulting in "fitted" employment impacts. The means for these fitted values, plus their first and second standard deviation intervals, are presented in Table 14. To preclude skewing these figures toward 0, they are based only on observations where $PDEFCHG_{jt}$, $NDEFCHG_{jt}$, and $BDEFCHG_{jt}$, respectively, did not reflect values of 0 (the number of inclusive observations is noted). Calculated values are reported for the period 1979-97 (1989-97 in the case of BRAC related personnel changes), and then for the first and last years of this interval for comparative purposes.

While there is very little variability in the fitted values for ordinary negative defense personnel changes, those of BRAC related personnel losses are dispersed widely about the mean. This rough sketch of defense employment effects seems to suggest that in general, the community infrastructure vacuum

Table 14 – Fitted Effects of Defense Personnel Changes on County Level Employment

Period	- 2SD	-1SD	Mean	+ 1SD	+ 2SD	Obs
Fitted Effects of Positive Defense Personnel Changes						
1979-97	**0.32**	**0.40**	**0.48**	**0.56**	**0.64**	**3645**
1979 only	-0.20	0.15	**0.49**	0.84	1.18	197
1997 only	0.46	0.47	**0.48**	0.49	0.50	140
Fitted Effects of Ordinary Negative Defense Personnel Changes						
1979-97	**-0.70**	**-0.69**	**-0.68**	**-0.67**	**-0.66**	**3914**
1979 only	-0.75	-0.71	**-0.67**	-0.63	-0.59	190
1997 only	-0.69	-0.68	**-0.68**	-0.68	-0.68	239
Fitted Effects of BRAC Related Negative Defense Personnel Changes						
1989-97	**-2.08**	**-1.45**	**-0.82**	**-0.18**	**0.45**	**341**
1989 only	-1.18	-1.05	**-0.91**	-0.78	-0.65	9
1997 only	-1.46	-1.18	**-0.91**	-0.63	-0.36	71

created through BRAC made for favorable employment conditions.[50] But, the degree of these effects varies appreciably from base to base, and in few cases, favorable effects are not present. Interestingly, the mean value of -0.82 is six percent less than the estimate of -0.87 in the same model, before incorporation of interaction terms. The failure to consider the elasticity of defense personnel changes to changes in industry and workforce composition may have led to some downward (negative) bias for this variable.

Long Run Employment Effects

Referring back to the development of the partial adjustment model in equation (2), page 47, the coefficients for all the defense and control variables include the apportioning factor λ, such that $0 \leq \lambda \leq 1$. The implication is that the estimated coefficient values for all these variables represent the short run component of their employment effects. As Greene (2000) notes, the corresponding long run effects can be recovered utilizing the parameter estimate for the lagged dependent variable (or it's instrument, in this study). Specifically, the coefficient for $EMPCHG^*_{j,t-1}$ is $(1-\lambda)$ in equation (2). From Table 13, $(1-\lambda) = 0.26$, so $\lambda = 0.74$. Dividing coefficient estimates for the remaining variables in Table 13 by 0.74 yields their estimated long run effects on county level non-farm private employment. For example, the model results suggest the long run

[50] Of the fitted values, 95 percent fall between -2.08 and 0.45, with an overall mean of -0.82. Recall observed values for ordinary and BRAC related personnel decreases are negative, so these negative coefficient estimates imply positive employment effects).

employment effect of installation reutilization is 2.01/0.74 = 2.70 jobs for every acre divested. Estimated long run effects of defense personnel changes are determined similarly. Using coefficient estimates from Table 12 (before interactions) and the means from the fitted values on Table 14 (after interactions), long run employment effects are approximated in Table 15.

The figures in Table 15 indicate the long run employment effects of defense personnel increases are on the order of 0.65. In other words, for 100 new military base workers, outside employment increases by 48 in the year of change, and by a total of 65 over the long run. This translates to a long run multiplier of 1.65. In periods of ordinary downsizing, the loss of 100 defense jobs frees up the labor and community infrastructure necessary to attract a net of 68 new jobs in the year of change, and a total of 92 over the long run. The implied long run multiplier for ordinary reductions, then, is 1 - 0.92 = 0.08. Finally, in the case of BRAC related downsizing, the loss of 100 defense jobs frees up the labor, community infrastructure, and defense facilities to generate a net of 82 new jobs in the year of change, and a total of 110 over the long run. This leads to a long run multiplier of –0.10 for BRAC related reductions. Once again, care should be taken in interpreting multipliers for both ordinary and BRAC related reductions. Specifically, these estimates are derived from data covering a period when outsourcing was commonplace. Furthermore, over one billion dollars in federal assistance was channeled to BRAC communities to aid in reutilization efforts and provide economic relief. The details necessary to model and control for both these factors were not available. At best, the "closure clock" dummy

Table 15 – Estimated Long Run Employment Effects

Before Interactions (Table 12)	After Interactions (Table 13)
Positive Personnel Changes	
0.49 / 0.74 = 0.66	0.48 / 0.74 = 0.65
Ordinary Negative Personnel Changes	
-0.68 / 0.74 = -0.91	-0.68 / 0.74 = -0.92
BRAC Related Negative Personnel Changes	
-0.87 / 0.74 = -1.16	-0.82 / 0.74 = -1.10

regime captures a portion of the financial aid influence. The remaining effects of these two factors are likely embedded in the ordinary and BRAC related downsizing multipliers. Under similar conditions, similar results may be expected. But, in the case where aid is not provided, or downsizing takes place without substitution, or outsourcing, the favorable employment effects of defense reductions are certain to be somewhat less than these estimates suggest.

Chapter V

CONCLUSION

This empirical study explored the general effects of military installations on local employment, and the special case of closure under the Base Realignment and Closure (BRAC) proceedings of 1988, 1991, 1993, and 1995. A novel panel data set incorporating 21 years of military and private industry observations for 963 military installations and 3,092 counties allowed comprehensive modeling and examination of defense related employment trends across all 50 states. The collection of sub-county defense personnel figures addressed a shortcoming of other county-level impact studies, which reconcile community employment changes against base closure personnel losses, without consideration of personnel dynamics at other military installations within the same county. To the extent that counties host more than one base, resulting impact estimates of such studies are biased. This outcome is highly likely given the data set revealed 88 counties hosting 97 major BRAC sites, were also home to 195 other military facilities that continued operations through the draw downs.

Particular attention was given to the propositions that while increases in defense personnel spur positive employment effects (+/+), ordinary personnel

decreases, and those occurring under base closure conditions, exert favorable employment pressures as well (-/+). These hypotheses run counter to conventional wisdom. In particular, the implicit assumption of economic base theory and input-output modeling techniques is that impacts of defense personnel changes on local employment are symmetrical. In other words, the effects of employment build-up are equal, but opposite in sign to those of job removal. This conclusion stands to reason from a gross impact perspective. But from a net impact perspective, this idea is challenged through simple reasoning. New growth and expansion of existing operations is certain to create jobs related to facilities and infrastructure construction and maintenance. Abandonment is likely to have an opposite effect of equal magnitude. But, abandonment is also likely to spur job creation through job destruction, particularly if there is a demand for a low cost alternative to new construction and infrastructure development.

The changes specification allowed examination of asymmetrical effects through decomposition of defense personnel changes into its positive, negative, and BRAC related components. Ordinary indirect and induced effects that accompany exogenous employment growth easily justify the +/+ hypothesis. The -/+ proposition is defended through: (1) the labor force redistributive effect of defense recruiting and attrition dynamics; (2) the community and public goods infrastructure vacuum that accompanies military downsizing; and (3) the countervailing employment effects of economic aid and reutilization efforts targeted at base closure sites.

There is evidence of an asymmetrical relationship between military personnel level changes, and local community employment. Specifically, coefficient estimates suggest the short and long run indirect and induced employment effects of positive defense personnel increases on local non-farm private employment are 0.48 and 0.65, respectively. The corresponding multipliers for military installation personnel increases, then, are 1.48 and 1.65. With respect to ordinary personnel reductions, the short and long run coefficient estimates are -0.68 and -0.92, respectively. The inferred multipliers, then, are 0.32 and 0.08. Interpreting this literally, in the short run, if one job is removed from a base, the net loss to the community is: -1 defense worker + 0.68 private industry workers = - 0.32 net job loss (or -1 x 0.32 = -0.32). Likewise, the average estimated short and long run effects of personnel reductions for BRAC locations are -0.82 and -1.10, respectively, which suggest multipliers of -0.18 and +0.10. However, care must be exercised in interpreting coefficient estimates for negative personnel changes (ordinary and BRAC related). Specifically, though the corresponding variables were chosen to capture the effects of labor force supply side pressures and community and public goods infrastructure vacuums, they also embody the effects of government outsourcing, and over one billion dollars in federal relief targeted at BRAC communities across a window of 9 years. A weakness of this study is the absence of detailed data to control for these two factors. For example, defense spending records that might capture the extent of outsourcing at the local levels, reflect only the point of payment to prime contractors, rather than the communities which derive employment benefits from

this spending. Regarding BRAC related financial aid, effort was made to control for this factor in the form of a base "closure clock" dummy variable regime. But the broad assumption here is that aid was apportioned evenly across all BRAC locations, under the same relative payout schedules. Naturally, the coefficients for negative personnel changes reflect one or both of these flaws. Since both these factors exert positive employment pressures, it is likely the estimated employment effects of military downsizing (BRAC and ordinary) are upward biased. This does not rule out support for asymmetrical employment effects related to defense workforce dynamics. But it does suggest that absent similar aid and outsourcing patterns, the estimated effects of downsizing are a bit optimistic.

Of interest is the differential between coefficient estimates for ordinary negative personnel changes and BRAC related personnel reductions. Specifically, the favorable employment effects associated with BRAC reductions were 20 percent greater than those estimated for ordinary downsizing. Again, federal assistance is a likely contributor to this difference. But, in conjunction with the positive and significant coefficient estimate for the installation and facilities reutilization proxy, $LANDCHG_{j,t-3}$, this implies efforts to promote conversion of public resources to private use were generally effective.

Though review of the literature, media, and defense records revealed only anecdotal support for claims of delays in delivery of aid and conversion of defense facilities, empirical results of the model corroborate these assertions. Specifically, after considering various lags for the reutilization proxy,

$LANDCHG_{j,?}$, the three-year lag specification fit best with the remaining variables. The implication is that on average, three years lapsed between vacancy and the final parceling of facilities for private reuse. Furthermore, significance and magnitudes for the "closure clock" dummy regime suggest the effects of financial aid and efforts to promote conversion kicked in on the second year, and reached their peak by the fourth year, following selection for closure.

There is little support for the idea that defense employment impacts in counties characterized by more specialized industry structures are dampened. While this expectation is explicitly modeled, and the signs of the coefficient estimates are as anticipated (with the exception of BRAC related personnel reductions), in all cases they do not test significantly different from 0. On the other hand, for BRAC related personnel reductions, there is evidence that favorable employment effects are less pronounced in communities where overall defense presence is also dwindling.

The idea of downsizing and closure is never appealing – particularly to those whose jobs are being eliminated and the communities that host them. But, in the case of DoD personnel and infrastructure reductions, the picture is not all doom and gloom. For example, the potential for reutilization of public assets represents low cost alternatives to new construction for private industry. Off-base housing and infrastructure released to the community by departing servicemen and women also present low cost expansion opportunities. Perhaps those who suffer most are the landholders, whose property values may depreciate in the wake of BRAC (as evidenced by programs to offset housing

sales losses sustained by defense personnel leaving closure communities). But, even this temporary setback serves to draw new growth and opportunity for the effected community. Though there will always be an exception – individuals or communities that suffer more than the results of this study suggest – these exceptions must be balanced against the bigger picture: a Department of Defense with a growing mission, constrained budgets, and aging, idle infrastructure that is sapping much needed funds away from operations and modernization. This study represents just one step toward reconciling those competing concerns.

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Appendices

Appendix A - PCI Growth as the Dependent Variable

Local employment effects of changes to defense operations are not the only worry of political representatives, civic leaders, and residents of affected communities. Resulting changes in the earnings of those left behind are also a serious concern. Though the focus of this study is not with that concern, a rough adaptation of the model on page 97 is explored to shed some light in this area. Specifically, using the model in equation (12), the *percent change in per capita income* ($PCIGROTH_{jt}$) is substituted as the dependent variable, while $PCIGROTH_{j,t-2}$ is used as an instrumental variable for the lagged dependent variable, $PCIGROTH_{j,t-1}$ (IV denoted: $PCIGROTH^{*}_{j,t-1}$). The purpose is not to precisely model regional earnings growth, but rather to see how the previously modeled employment determinants might influence income, with particular attention given to the direction of *defense personnel* and *installation reutilization* effects. The model is run in three variations, with defense personnel changes (1) aggregated into one variable (1-way defense change); (2) decomposed into positive and negative changes only (2-way defense change); and (3) decomposed into positive changes, negative changes related to on-going

operations, and negative changes related to BRAC (3-way defense change). The outcomes for all three are presented in Table A-1.

Of interest are the consistently positive coefficients for all the defense personnel variables in all three models. In particular, *defense personnel changes* ($DEFCHG_{jt}$) in the 1-way model, and *positive defense personnel changes* ($PDEFCHG_{jt}$) in the 2- and 3-way models are both positive *and* significant. Looking at the $DEFCHG_{jt}$ coefficient in the 1-way model, its value of 0.000003 seems to suggest an increase of 3,310 military and federal civilian defense jobs leads to regional per capita income growth of 1%. Of course specification issues and the possibility of omitted variable bias place the magnitudes of these parameter estimates in question. But, the positive direction deserves attention as it suggests defense personnel typically increase earnings averages for their communities. This is consistent with the interpretation of the stand-alone defense-to-labor force change variable, $D2LFCHG_{j,t-1}$, in the interaction model of Table 13 (see related discussion, beginning on page 111). These combined results run counter to those of Hooker and Knetter. Specifically, Hooker and Knetter (1999) find local defense personnel decreases lead to per capita income increases. It should be noted their study is restricted to a much smaller sampling (California only), and their coefficients do not test significantly different from 0. While it may be that in a few high cost areas, military presence does indeed bring down overall earnings averages, the results of this study suggest that on the whole, just the opposite is true.

Table A – *Changes* Model with PCI Growth as the Dependent Variable

Dependent Variable: $PCIGROTH_{jt}$

	Coeff	T-Stat	Coeff	T-Stat	Coeff	T-Stat
Λ_t	not shown		not shown		not shown	
$DEFCHG_{jt}$	0.000003	2.58 **				
$PDEFCHG_{jt}$			0.000005	2.67 **	0.000005	2.68 **
$NDFCHG_{jt}$			0.000002	1.17	0.000002	1.23
$BDEFCHG_{jt}$					0.000001	0.28
$DEFDV_j$	-0.000284	-0.48	-0.000521	-0.84	-0.000494	-0.79
$LANDCHG_{j,t-3}$	0.000002	0.37	0.000002	0.35	0.000002	0.32
$T0_{jt}$	0.002563	0.37	0.002181	0.32	0.002306	0.33
$T1_{jt}$	-0.011460	-1.61	-0.011990	-1.68	-0.012398	-1.72
$T2_{jt}$	0.005317	0.75	0.004468	0.63	0.003857	0.53
$T3_{jt}$	-0.005809	-0.67	-0.007114	-0.82	-0.008007	-0.88
$T4_{jt}$	0.001968	0.23	0.001249	0.14	0.000662	0.08
$T5_{jt}$	-0.012042	-1.06	-0.012766	-1.12	-0.013416	-1.16
$STNRGYCH_{j,t-1}$	0.001623	1.87	0.001619	1.87	0.001620	1.87
$PPICHG_{j,t-1}$	-0.010502	-9.87 **	-0.010500	-9.87 **	-0.010501	-9.87 **
$SLGCHG_{jt}$	0.000002	3.05 **	0.000002	2.93 **	0.000002	2.94 **
PCIMPLCH	-0.000009	-0.81	-0.000009	-0.83	-0.000009	-0.83
$PWRCHG_{j,t-1}$	0.004364	12.41 **	0.004364	12.41 **	0.004365	12.41 **
$PCFEACHG_{j,t-1}$	-0.000081	-2.87 **	-0.000081	-2.87 **	-0.000081	-2.87 **
$DNSITYCH_{j,t-1}$	-0.000052	0.00	-0.000057	-0.01	0.000097	0.01
$PSRVCCHG_{j,t-1}$	-0.021732	-1.31	-0.021673	-1.31	-0.021674	-1.31
$POPECHG_{j,t-1}$	0.003185	0.25	0.003268	0.26	0.003267	0.26
$CSCHG_{j,t-1}$	0.093040	5.12 **	0.093124	5.12 **	0.093107	5.12 **
$FARMCHG_{jt}$	0.000007	2.88 **	0.000007	2.89 **	0.000007	2.89 **
$PCIGROTH^*_{j,t-1}$ (IV: $PCIGROTH_{j,t-2}$)	-0.000018	-3.69 **	-0.000018	-3.69 **	-0.000018	-3.69 **
Final est. of Rho	-0.290191	-73.50 **	-0.290199	-73.50 **	-0.290201	-73.50 **

(counties, n = 3092; periods, T = 19)

* Significant at the 95 percent level.

** Significant at the 99 percent level.

Note: Models corrected for first order autocorrelation.

The other noteworthy results are the coefficient for the *installation reutilization proxy* ($LANDCHG_{jt}$) is positive in all three models, and that of the defense county dummy variable, $DEFDV_j$, is negative in all three. The $LANDCHG_{jt}$ result implies reutilization has favorable effects on local earnings, whereas the sign for $DEFDV_j$ suggests, ceteris paribus, earnings growth in defense counties trail that of non-defense counties. But, both these effects do not test significantly different from 0.

Appendix B - First Stage of Instrumental Variable Estimation

The equation estimated in the first stage of the 2SLS routine, when $EMPCHG_{j,t-2}$ is the instrument for the lagged dependent variable $EMPCHG_{j,t-1}$, follows:

$$
\begin{aligned}
EMPCHG_{j,t-1} \quad = {} & \Lambda_t \\
& + \lambda\beta_1 DEFCHG_{jt} \\
& + \lambda\beta_2 DEFDV_j \\
& + \lambda\beta_3 LANDCHG_{jt} \\
& + \lambda\gamma_1 STNRGYCH_{j,t-1} \\
& + \lambda\gamma_2 PPICHG_{j,t-1} \\
& + \lambda\gamma_3 SLGCHG_{jt} \\
& + \lambda\gamma_4 PCIMBPCH_{j,t-1} \\
& + \lambda\gamma_5 PWRCHG_{j,t-1} \\
& + \lambda\gamma_6 PCFEACHG_{j,t-1} \\
& + \lambda\gamma_7 DNSITYCH_{j,t-1} \\
& + \lambda\gamma_8 PSRVCCHG_{j,t-1} \\
& + \lambda\gamma_9 POPECHG_{j,t-1} \\
& + \lambda\gamma_{10} CSCHG_{j,t-1} \\
& + \lambda\gamma_{11} FARMCHG_{jt} \\
& + (1-\lambda)\, EMPCHG_{j,t-2} \\
& + e_{jt}
\end{aligned}
\tag{17}
$$

Note that this first equation takes the same form as the original regression model, with the exceptions that the lagged dependent variable is substituted for

the dependent variable, and the instrument is substituted for the lagged dependent variable. Results are summarized in Table B-1. For the second stage of the routine, fitted values of $EMPCHG_{j,t-1}$ are derived from these estimated coefficients, then substituted back into the original regression equation, yielding the results presented in Table 8 on page 92.

Table B – First Stage Results from Instrumental Variable Estimation

Dependent Variable: $\mathbf{EMPCHG_{j,t-1}}$

	Coeff	T-Stat	
Λ_t	not shown		
$DEFCHG_{jt}$	-0.18	-3.38	**
$DEFDV_j$	618.18	18.20	**
$LANDCHG_{jt}$	0.86	4.37	**
$STNRGYCH_{j,t-1}$	-188.12	-4.62	**
$PPICHG_{j,t-1}$	-737.35	-14.43	**
$SLGCHG_{jt}$	1.83	60.96	**
$PCIMBPCH_{j,t-1}$	-2.40	-4.38	**
$PWRCHG_{j,t-1}$	13.29	0.79	
$PCFEACHG_{j,t-1}$	-1.22	-0.97	
$DNSITYCH_{j,t-1}$	8130.73	13.70	**
$PSRVCCHG_{j,t-1}$	-258.46	-0.34	
$POPECHG_{j,t-1}$	-1425.66	-2.43	*
$CSCHG_{j,t-1}$	7208.86	8.44	**
$FARMCHG_{jt}$	-0.43	-3.99	**
$EMPCHG_{j,t-2}$	0.63	204.64	**

(counties, n = 3092; periods, T = 19)

* Significant at the 95 percent level.

** Significant at the 99 percent level.

Appendix C - Major BRAC Bases

Installation/City	County	First BRAC*	State
Adak Naval Air Station	Juneau Borough	1995	AK
Fort Greely	S.E. Fairbanks Census Area	1995	AK
Fort McClellan	Calhoun	1995	AL
Fort Chaffee	Sebastian	1995	AR
Ira Eaker Air Force Base	Mississippi	1991	AR
Williams Air Force Base	Maricopa	1991	AZ
Alameda	Alameda	1993	CA
Castle Air Force Base	Merced	1991	CA
El Toro Marine Corps Air Station	Orange	1993	CA
Fort Ord	Monterey	1991	CA
George Air Force Base	San Bernardino	1988	CA
Long Beach	Los Angeles	1991	CA
March Air Force Base	Riverside	1993	CA
Mare Island Naval Shipyard	Solano	1993	CA
Mather Air Force Base	Sacramento	1988	CA
McClellan Air Force Base	Sacramento	1995	CA
Norton Air Force Base	San Bernardino	1988	CA
Oakland Military Complex	Alameda	1993	CA
Onizuka Air Force Base	Santa Clara	1995	CA
Port Hueneme	Ventura	1993	CA
Sacramento	Sacramento	1991	CA
San Diego	San Diego	1993	CA
San Francisco	San Francisco	1988	CA
Sierra Army Depot	Lassen	1995	CA
Tustin Marine Corps Air Station	Orange	1991	CA
Aurora	Arapahoe	1995	CO
Lowry Air Force Base	Denver	1991	CO
Pueblo	Pueblo	1988	CO
New London	New London	1995	CT
Stratford	Fairfield	1995	CT
Cecil Field Naval Air Station	Duval	1993	FL
Homestead Air Force Base	Miami-Dade	1993	FL
Key West Naval Air Station	Monroe	1995	FL
Orlando	Orange	1993	FL
Pensacola	Escambia	1993	FL
Barbers Point Naval Air Station	Honolulu	1993	HI
Chanute Air Force Base	Champaign	1988	IL
Fort Sheridan	Lake	1988	IL
Glenview	Cook	1993	IL
Savanna Army Depot	Carroll	1995	IL

Installation/City	County	First BRAC*	State
Fort Benjamin Harrison	Marion	1991	IN
Grissom Air Force Base	Miami	1991	IN
Indianapolis	Marion	1995	IN
Jefferson Proving Ground	Jefferson	1988	IN
Lexington	Fayette	1988	KY
Louisville	Jefferson	1995	KY
England Air Force Base	Rapides	1991	LA
Fort Polk	Vernon	1991	LA
Fort Devens	Middlesex	1991	MA
Watertown	Middlesex	1988	MA
Weymouth	Norfolk	1995	MA
Annapolis	Anne Arundel	1995	MD
Baltimore	Baltimore (Independent City)	1995	MD
Fort Ritchie	Washington	1995	MD
Loring Air Force Base	Aroostook	1991	ME
Detroit	Macomb	1993	MI
K. I. Sawyer Air Force Base	Marquette	1993	MI
Warren	Macomb	1995	MI
Wurtsmith Air Force Base	Iosco	1991	MI
Richards-Gebaur Air Reserve Station	Cass	1991	MO
St. Louis	St. Louis (Independent City)	1995	MO
Pease Air Guard Station	Rockingham	1988	NH
Bayonne	Hudson	1995	NJ
Fort Dix	Burlington	1988	NJ
Fort Monmouth	Monmouth	1993	NJ
Trenton	Mercer	1993	NJ
Bethpage	Nassau	1995	NY
Fort Totten	Queens	1995	NY
Griffiss Air Force Base	Oneida	1993	NY
New York	Richmond	1993	NY
Plattsburgh Air Force Base	Clinton	1993	NY
Senaca Army Depot (Romulus)	Seneca	1995	NY
Kettering	Montgomery	1993	OH
Newark	Licking	1993	OH
Rickenbacker Air Force Base	Franklin	1991	OH
Kelly Support Facility	Westmoreland	1995	PA
Letterkenny Army Depot	Franklin	1995	PA
Philadelphia Military Complex	Philadelphia	1991	PA
Warminster	Bucks	1995	PA
Charleston	Charleston	1993	SC
Myrtle Beach Air Force Base	Horry	1991	SC
Memphis	Shelby	1995	TN
Millington	Shelby	1993	TN
Bergstrom Air Force Base	Travis	1991	TX
Carswell Air Force Base	Tarrant	1991	TX
Chase Field Naval Air Station	Bee	1991	TX
Dallas	Dallas	1993	TX
Kelly Air Force Base	Bexar	1995	TX
Red River Army Depot	Bowie	1995	TX
Reese Air Force Base	Lubbock	1995	TX
Ogden	Weber	1995	UT

Installation/City	County	First BRAC*	State
Tooele Army Depot	Tooele	1993	UT
Cameron Station	Alexandria (Independent City)	1988	VA
Fort Pickett	Nottoway	1995	VA
Norfolk	Norfolk (Independent City)	1993	VA
Vent Hill Farm Stations (Warrenton)	Fauquier	1993	VA
Seattle	King	1988	WA

* In a few cases bases were effected by more than one BRAC. In these instances, the date reflects the first BRAC to impact the base.

Appendix D - List of Acronyms

Acronym	Full Text
AD	Army Depot
AFB	Air Force Base
AFS	Air Force Station
AGB	Air Guard Base
ARS	Air Reserve Base
BEA	Bureau of Economic Analysis
BLS	Bureau of Labor and Statistics
BRAC	Base Realignment and Closure
CBO	Congressional Budget Office
CMSA	Consolidated Metropolitan Statistical Area
COBRA	Cost of Base Realignment Action
CRS	Congressional Research Service
DoD	Department of Defense
DOE	Department of Energy
DOL	Department of Labor
EDA	Economic Development Administration
EIA	Energy Information Administration
FAA	Federal Aviation Administration
GAO	General Accounting Office
KWH	Kilowatt Hour
LMI	Logistics Management Institute
MCAS	Marine Corps Air Station
MSA	Metropolitan Statistical Area
NAS	Naval Air Station
OEA	Office of Economic Adjustment
OSD	Office of the Secretary of Defense
PMSA	Primary Metropolitan Statistical Area
QDR	Quadrennial Defense Review
REIS	Regional Economic Information System
RIMS	Regional Input-Output Modeling System

Acronym	Full Text
ROTC	Reserve Officer Training Corps
SAF	Secretary of the Air Force
SEPER	State Energy Price and Expenditure Report
U.S.C.	United States Code
USDC	United States Department of Commerce

Vita

Patrick Poppert was born in Lincoln, Nebraska. He attended schools in the public systems of Tacoma, Washington, where he graduated from Clover Park High School in June, 1982. Upon graduation, he entered the United States Air Force Academy, Colorado Springs, Colorado. In May, 1986 he received his Bachelor of Science in General Studies and was commissioned a regular officer in the United States Air Force. He subsequently earned a Master of Business Administration in Aviation Management from Embry-Riddle Aeronautical University (1989), a second Bachelors of Science degree in Accounting from Rollins College (1991), and a Master of Science in Cost Analysis from the Air Force Institute of Technology (1992). He entered the Doctor of Philosophy program in Economics at the University of Tennessee, Knoxville in August of 1997, officially receiving the Doctoral degree in December 2001.

Patrick has been on continuous active duty with the Air Force since his commissioning in 1986. He has mastered a variety of specialties in the financial management career field, to include base level internal auditing, weapons system cost analysis, and command level flying operations and training budget and resource management. Presently, he serves as the faculty economics

and resource management. Presently, he serves as the faculty economics expert for the Department of Defense Professional Military Comptroller School, Maxwell Air Force Base, Alabama. The school is responsible for conducting a six week residence course that provides mid- to senior-level DoD personnel financial management instruction and exposure to contemporary issues facing defense resource managers.

Patrick received the Outstanding Accounting Student award from Rollins College in 1991. He also holds a number of professional designations, to include Certified Public Accountant (CPA), Certified Internal Auditor (CIA), Certified Management Accountant (CMA), and Certified in Financial Management (CFM). He has been a member of the Institute of Internal Auditors and the Institute of Management Accountants since 1990.